UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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Memorandum

Date: August 5, 2020

Subject: Volume III – Comparative Analyses
Feasibility Study Report
Olin Chemical Superfund Site
Wilmington, Massachusetts

To: File

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PURPOSE AND BACKGROUND

The draft Remedial Investigation (RI) Report for Operable Unit (OU) 3, dated June 2019 (Draft 2019 OU3 RI Report),[1] the Final RI Report for OU1/OU2, dated July 2015 (2015 OU1/OU2 RI Report),[2] and the Jewel Drive Dense Aqueous Phase Liquid (DAPL) Extraction Pilot Report, dated November 2014,[3] summarize the nature and extent of contamination at the Olin Chemical Superfund Site (Site) in Wilmington, Massachusetts. These documents, supplemented by two memoranda prepared by EPA entitled, *Updates to OU1/OU2 RI Report Conclusions*, dated August 5, 2020[4] and *Updates to Draft OU3 RI Report Conclusions*, dated August 5, 2020,[5] were used to prepare a Feasibility Study (FS) report for the Site (FS report). The FS report is composed of a Volume I, OU1/OU2 FS Report, dated July 31, 2020 (OU1/OU2 FS Report),[6] a Volume II, Interim Action FS (IAFS) Report, dated August 3, 2020 (IAFS Report),[7] and this Memorandum, which serves as Volume III.

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[1] *Draft Revised Remedial Investigation Report, Operable Unit 3, Olin Chemical Superfund Site, Wilmington, Massachusetts,* Wood, June 2019 (Draft 2019 OU3 RI Report)
[2] *Final Remedial Investigation Report, Operable Unit 1 & Operable Unit 2, Olin Chemical Superfund Site, Wilmington, Massachusetts,* AMEC, July 24, 2015 (2015 OU1/OU2 RI Report)
[3] *DAPL Extraction Pilot Study, Performance Evaluation Report, Olin Chemical Superfund Site, 51 Eames Street, Wilmington, Massachusetts,* AMEC, November 7, 2014
[4] Memorandum, *Olin Chemical Superfund Site, Updates to OU1/OU2 RI Report Conclusions*, EPA, August 5, 2020.
[5] Memorandum, *Olin Chemical Superfund Site, Updates to OU3 RI Report Conclusions*, EPA, August 5, 2020.
[6] *Volume 1, Operable Unit 1 & Operable Unit 2 Feasibility Study, Olin Chemical Superfund Site, 51 Eames Street, Wilmington, Massachusetts,* Olin Corporation, July 31, 2020 (OU1/OU2 FS Report)
[7] *Volume II, Interim Action Feasibility Study, Olin Chemical Superfund Site, 51 Eames Street, Wilmington, Massachusetts,* Olin Corporation, August 3, 2020 (IAFS Report).

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Volumes I and II of the FS report identify the full range of alternatives that EPA considered for the cleanup of the Site.[8] These volumes evaluate the efficacy of different cleanup alternatives to protect human health and the environment by preventing risk of exposure to Site-related contaminants in DAPL, Light Non-Aqueous Phase Liquid (LNAPL), groundwater, surface water, indoor air, soil, soil vapor, and sediments. The investigation was split into several components that address different locations within the Site and varied contaminated media, generally final remedial action alternatives for OU1/OU2 (Olin property soil, sediments, and surface water) and interim remedial action alternatives for OU3 (groundwater).

Volumes I and II of the FS report screened, developed, and evaluated alternatives for the following eight cleanup components:

- DAPL
- Groundwater Hot Spots
- LNAPL
- Surface Water
- Containment Area Soil
- Upland Soil
- Wetland Soil and Sediments
- Trimethylpentenes (TMPs) in Soil

This Memorandum, as Volume III of the FS report, consolidates the cleanup components, as initially presented in Volumes I and II of the FS report, into three groupings:

- DAPL and Groundwater Hot Spots
- LNAPL and Surface Water
- Soil and Sediments (Containment Area Soil, Upland Soil, Wetland Soil and Sediments, and TMPs in Soil)

As Volume III of the FS report, this Memorandum provides the rationale for consolidating cleanup components and the initial screening-out of certain alternatives developed in Volumes I and II. Further, this Memorandum presents a detailed comparative analysis of the remedial alternatives considered for these three sets of cleanup components.

Section I of this Memorandum summarizes the eight cleanup components and associated remedial alternatives from Volumes I and II of the FS report. Section II of the Memorandum introduces a new Remedial Action Objective (RAO) for OU1 and OU2 that was not included in the OU1/OU2 FS Report or IAFS Report and the cleanup alternatives to address this RAO. Section III of the Memorandum introduces the three sets of consolidated cleanup components and provides a nomenclature for the groupings. Section IV provides further rationale and information on the cleanup alternatives considered

[8] The IAFS Report (Volume II of the FS report) presents the range of alternatives to address DAPL, groundwater hot spots, LNAPL, and Containment Area soil. While the latter two cleanup components were originally grouped with the DAPL and groundwater hot spot evaluations due to their connection to groundwater (in the case of LNAPL, which, together with dissolved-phase constituents in groundwater, is captured by Plant B prior to impacting East Ditch Stream, and in the case of Containment Area soil, for its relationship to the Containment Area DAPL pool and hot spot groundwater), the alternatives developed for LNAPL and Containment Area soil would not be interim, but final remedial action alternatives.

for each of the three consolidated cleanup components. Section V presents EPA's nine criteria for choosing a cleanup plan. Section VI provides an overview of how EPA compares cleanup alternatives to the nine criteria. Section VII presents a detailed comparative analysis of the cleanup alternatives for DAPL and groundwater hot spots. Section VIII presents a detailed comparative analysis of the cleanup alternatives for LNAPL and surface water. Section IX presents a detailed comparative analysis of the cleanup alternatives for soil and sediments. Section X provides a list of acronyms. These sections are followed by two appendices – Appendix A, which provides a series of tables, and Appendix B, which provides a series of figures.

I. SUMMARY OF THE EIGHT CLEANUP COMPONENTS AND ASSOCIATED REMEDIAL ALTERNATIVES FROM VOLUMES I AND II OF THE FS REPORT

To address the possible exposure pathways and potential risks that were identified at the Site for DAPL and Groundwater Hot Spots, LNAPL and Surface Water, and Soil and Sediments, cleanup alternatives were developed to reduce and/or mitigate the identified unacceptable risks and achieve the site-specific RAOs, which are also known as the cleanup objectives (see Sections VI, VII, and VIII, *Cleanup Alternatives Comparisons*, below).

Table 1, *Individual Cleanup Components and Remedial Alternatives in Volumes I and II of the FS report,* below, lists the eight cleanup components presented in Volumes I and II of the FS report and the accompanying remedial alternatives considered to address the risks posed by Site-related contaminants.

Due to the number and complexity of the remedial alternatives (34) considered to address the risks posed by Site-related contaminants, EPA sought to simplify and consolidate the cleanup components to promote public understanding of the interrelationship between the various cleanup components and to reduce the number and extent of comparative analyses required.

II. ADDITION OF NEW RAO AND REMEDIAL ALTERNATIVES

This Memorandum – Volume III of the FS report – introduces a new RAO for OU1/OU2 that was not included in either Volume I or II of the FS report:

- Prevent potential human exposure by a future resident to soil containing Site contaminants above levels that pose an unacceptable risk.

EPA's August 5, 2020 memorandum entitled, *Updates to OU1/OU2 RI Report Conclusions*[4] called for the addition of the above RAO subsequent to the development of the range of alternatives to address the pre-existing suite of RAOs in Volumes I and II of the FS report. Thus, alternatives to address this RAO were not included in either Volume I or II of the FS report. Therefore, this Memorandum presents the following alternative to address this RAO:

- Institutional Controls to prohibit future residential use at the Olin property.

Institutional Controls are non-engineered instruments, such as administrative and legal controls, that protect a remedy and public health by preventing or limiting exposure to hazardous substances, pollutants, or contaminants, where unrestricted use standards are not achieved. This RAO and the accompanying land use restriction prohibiting future residential use would apply to the entire Olin property (Property; OU1), as well as the off-Property, soil-containing portion of OU2 termed Human Health Exposure Area-5 (HH-EA5).[9] The land use restriction would be a component of each of the "action" (as opposed to "no action") alternatives developed to address contamination in DAPL, groundwater hot spots, LNAPL, surface water, soil, and sediments at the Site, discussed further in the sections below.

III. NOMENCLATURE AND RATIONALE FOR CONSOLIDATED CLEANUP COMPONENTS AND ASSOCIATED REMEDIAL ALTERNATIVES IN VOLUME III OF THE FS REPORT

Via this Memorandum, EPA streamlined the 34 alternatives listed in **Table 1**, *Individual Cleanup Components and Remedial Alternatives in Volumes I and II of the FS report* by consolidating the cleanup components into three groups, with each group including a range of remedial alternatives. (Note that each action alternative also includes the Institutional Controls component presented in Section II, above, to address the RAO of preventing potential human exposure by a future resident to soil containing Site contaminants above levels that pose an unacceptable risk.) **Table 2**, *Consolidated Cleanup Components and Remedial Alternatives in Volume III of the FS report,* below, lists the three cleanup component groups and the range of remedial alternatives considered to address the associated risks to human health and the environment, as well as presents the nomenclature for the alternatives.

The eight original cleanup components in Volumes I and II of the FS report (DAPL, groundwater hot spots, LNAPL, surface water, Containment Area soil, upland soil, wetland soil and sediments, and TMPs in soil) were first grouped by media, which resulted in the linking of DAPL with groundwater hot spots, LNAPL and its associated potential impacts to East Ditch Stream surface water with the broader category of surface water, and all of the soil and sediment alternatives together (Containment Area soil, upland soil, wetland soil and sediments, and TMPs in soil).

Once the three cleanup component groups were established, the 34 remedial alternatives were combined to form a range of alternatives. Firstly, alternatives making up the no action approach were grouped together. Secondly, a few alternatives developed for the original eight cleanup components were screened out. Alternatives LNAPL-2 (Manual Removal via Skimmers and Absorbent Socks) and LNAPL-3 (Continued Mechanical Recovery via Skimmers in Additional Recovery Wells) were screened out from further evaluation to address LNAPL contamination due to significant LNAPL mass that would remain on-site. Similarly, Alternative SW-2 (Limited Action – Surface Water and Groundwater Monitoring) was screened out from further evaluation to address surface water contamination due to contaminants that would remain on-site above levels that pose an unacceptable risk and failure to reduce contaminant toxicity, mobility, or volume through treatment. Both Alternatives SW-5 (Permeable Reactive Barrier) to address surface water contamination and TMP-4 (In-Situ Thermal Treatment) to address TMP contamination in soil were screened out due to their significantly high costs when compared to the costs of the other alternatives for those particular cleanup components, without any change in effectiveness of protecting human health and the environment.

[9] See Memorandum, *Olin Chemical Superfund Site, Updates to OU1/OU2 RI Report Conclusions,* EPA, August 5, 2020. Page 2. For the purposes of the risk assessments, EAs were established to facilitate evaluation of potential risks, centered around known releases and receptors.

IV. FURTHER DETAILS ON CLEANUP ALTERNATIVES CONSIDERED

A. DAPL AND GROUNDWATER HOT SPOTS

For the DAPL and Groundwater Hot Spots (DAPL/GWHS) cleanup component, three extraction-based alternatives were developed (see **Figure 1**, *Conceptual plan for Alternative DAPL/GWHS-2,* **Figure 2**, *Conceptual plan for Alternative DAPL/GWHS-3,* and **Figure 3**, *Conceptual plan for Alternative DAPL/GWHS-4,* below), in addition to the no action alternative (Alternative DAPL/GWHS-1), to target different concentrations of NDMA in overburden groundwater and various DAPL extraction strategies.[10] More details on the cleanup alternatives for DAPL and Groundwater Hot Spots are as follows:

Alternative DAPL/GWHS-1: No action alternative

Capital Cost	$0
Annual O&M Cost	$0
Present Worth Cost	$0
Construction Time	0 years
Time to Achieve RAOs	Not achieved

- As a baseline to compare against other alternatives, no action would be taken to address contamination in DAPL and groundwater hot spots. No construction would take place, and RAOs would not be achieved.

Alternative DAPL/GWHS-2: DAPL extraction (approx. 5 wells), groundwater hot spot extraction targeting 11,000 ng/L NDMA (approx. 2-3 wells), on-site treatment at new treatment system alternative

Capital Cost	$10.3 million
Annual O&M Cost	$21.7 million
Present Worth Cost	$22.5 million
Construction Time	2-3 years
Time to Achieve RAOs	20 years

- Construction and operation of a DAPL extraction system, conceptualized with one well in the Off-Property Jewel Drive DAPL pool, one well in the Containment Area DAPL pool, and three wells in the Main Street DAPL pool;
- Construction and operation of a groundwater extraction and treatment system, conceptualized with two-three wells targeting the 11,000 ng/L NDMA contour, to remove and treat the mass of contaminants in highly contaminated NDMA-containing groundwater (groundwater hot spots) in the areas downgradient of the Main Street DAPL pool; and

[10] The three extraction-based remedial alternatives are based on a data set that includes NDMA groundwater data from the March 2019 comprehensive groundwater sampling event. The March 2019 data was not available at the time that Volume I of the FS report was prepared, thus there are certain differences between the sets of figures in the IAFS Report (Volume II of the FS report) and this Memorandum (Volume III).

- On-site treatment of extracted DAPL and hot spot groundwater in a new, multi-phase treatment system. The location of the new treatment system has been shown for costing and comparison purposes only. The exact location of the treatment system will be determined following resolution of data gaps and completion of pre-design investigations.

Alternative DAPL/GWHS-3: DAPL extraction (approx. 20 wells), groundwater hot spot extraction targeting 5,000 ng/L NDMA (approx. 6 wells), on-site treatment at new treatment system alternative

Capital Cost	$15.6 million
Annual O&M Cost	$24.6 million
Present Worth Cost	$35.5 million
Construction Time	2-3 years
Time to Achieve RAOs	8 years

- Construction and operation of a DAPL extraction system, conceptualized with four wells in the Off-Property Jewel Drive DAPL pool, four wells in the Containment Area DAPL pool, and 12 wells in the Main Street DAPL pool;
- Construction and operation of a groundwater extraction and treatment system, conceptualized with six wells, targeting the 5,000 ng/L NDMA contour, to remove and treat the mass of contaminants in groundwater hot spots; and
- On-site treatment of extracted DAPL and hot spot groundwater in a new, multi-phase treatment system.

Alternative DAPL/GWHS-4: DAPL extraction (approx. 20 wells), groundwater hot spot extraction targeting 1,100 ng/L NDMA (approx. 12 wells), on-site treatment at new treatment system alternative

Capital Cost	$19.3 million
Annual O&M Cost	$26.5 million
Present Worth Cost	$40.5 million
Construction Time	2-3 years
Time to Achieve RAOs	8 years

- Construction and operation of a DAPL extraction system, conceptualized with four wells in the Off-Property Jewel Drive DAPL pool, four wells in the Containment Area DAPL pool, and 12 wells in the Main Street DAPL pool;
- Construction and operation of a groundwater extraction and treatment system, conceptualized with 12 wells, targeting the 1,100 ng/L NDMA contour, to remove and treat the mass of contaminants in groundwater hot spots; and
- On-site treatment of extracted DAPL and hot spot groundwater in a new, multi-phase treatment system.

B. LNAPL AND SURFACE WATER

For the LNAPL and Surface Water (LNAPL/SW) cleanup component, three alternatives were developed (see **Figure 4**, *Conceptual plan for Alternative LNAPL/SW-2,* **Figure 5**, *Conceptual plan for Alternative LNAPL/SW-3*, and **Figure 6**, *Conceptual plan for Alternative LNAPL/SW-4*, below), in addition to the no action alternative (Alternative LNAPL/SW-1). More details on the cleanup alternatives for LNAPL and Surface Water are as follows:

Alternative LNAPL/SW-1: No action alternative

Capital Cost	$0
Annual O&M Cost	$0
Present Worth Cost	$0
Construction Time	0 years
Time to Achieve RAOs	Not achieved

- As a baseline to compare against other alternatives, no action would be taken to address contamination from LNAPL and in surface water. No construction would take place, and RAOs would not be achieved.

Alternative LNAPL/SW-2: MPE for LNAPL with treatment at Plant B, groundwater extraction to prevent discharge of contaminants to surface water, on-site treatment at new treatment system alternative

Capital Cost	$4.6 million
Annual O&M Cost	$6.5 million
Present Worth Cost	$9.0 million
Construction Time	2-3 years
Time to Achieve RAOs	30 years

- Construction and operation of one MPE well, located just outside of the northeast corner of the Plant B building near monitoring well GW-23, where the thickest LNAPL accumulation is observed;
- Use of an oil/water separator to remove LNAPL and granular activated carbon (GAC) to treat vapors as part of the skid-mounted system, and conveyance of extracted groundwater to Plant B for additional treatment;
- Storage of extracted LNAPL on-site, with off-site disposal at an appropriate off-site permitted facility;
- Construction and operation of a groundwater extraction system, with extraction wells adjacent to East Ditch Stream, South Ditch Stream, and Off-Property West Ditch Stream, to intercept and treat the overburden groundwater plume discharging contaminated groundwater into these streams; and
- Treatment and discharge of extracted groundwater at a newly constructed, on-site, groundwater treatment system (the same one as the groundwater hot spot treatment system).

Alternative LNAPL/SW-3: Demolition of Plant B, Expanded MPE for LNAPL, targeted groundwater extraction to prevent discharge to surface water, on-site treatment at new treatment system alternative

Capital Cost	$2.3 million
Annual O&M Cost	$7.4 million
Present Worth Cost	$6.6 million
Construction Time	2-3 years
Time to Achieve RAOs	30 years

- An estimated three to five MPE wells installed within the LNAPL footprint, including beneath the Plant B building foundation to remediate LNAPL, the smear zone, and dissolved-phase Site contaminants that would otherwise impact East Ditch Stream;
- Treatment of recovered LNAPL and soil vapor via a skid-mounted treatment system that includes an oil/water separator to remove the LNAPL and vapor-phase GAC to treat the soil vapor;
- Off-site disposal of LNAPL at an appropriate off-site permitted facility;
- Construction and operation of a new groundwater extraction and treatment system, with extraction wells along Off-Property West Ditch Stream, at locations upgradient (west and northwest) of the weir at the upstream location of South Ditch Stream, and midway along South Ditch Stream between the weir and discharge location where South Ditch Stream meets East Ditch Stream, to intercept and treat the overburden groundwater plume discharging contaminated groundwater into these streams;
- Re-routing of groundwater treated by Plant B from the three wells along East Ditch Stream to the new groundwater treatment system (the same one as the groundwater hot spot treatment system); and
- Decommissioning and demolition of the Plant B groundwater treatment system.

Alternative LNAPL/SW-4: Excavation of LNAPL with off-site disposal, targeted PRBs to treat groundwater before discharge into surface water

Capital Cost	$5.3 million
Annual O&M Cost	$6.7 million
Present Worth Cost	$9.0 million
Construction Time	1 year
Time to Achieve RAOs	30 years

- Decommissioning and demolition of Plant B;
- Excavation of LNAPL-impacted soil to the bottom of the smear zone;
- Dewatering and stabilization of soil, as necessary;
- Post-excavation confirmatory sampling to document limits of soil impacts and confirm achievement of RAOs;
- Off-site disposal of all excavated material at an appropriate off-site permitted facility;

- Construction and installation of PRBs along portions of South Ditch Stream, with grouted sheet-pile walls to direct groundwater through the PRBs, the design of which will be based on additional data obtained during pre-design investigations and may include additional segments of PRB in other areas to address East and Off-Property West Ditch Streams; and
- Short-term continued operation of Plant B is assumed for this alternative until the new groundwater hot spot treatment system is constructed and operational. At this point, groundwater extracted from the three wells along East Ditch Stream will be re-routed to the new groundwater treatment system. If Plant B were to be shut down prior to construction of the new treatment system, an evaluation of site hydrogeology would be performed first to ensure continued protection of human health and the environment.

C. WETLAND SOIL AND SEDIMENTS

For the Wetland Soil and Sediments (SOIL/SED) cleanup component, three alternatives were developed (see **Figure 7**, *Conceptual plan for Alternative SOIL/SED-2*, **Figure 8**, *Conceptual plan for Alternative SOIL/SED-3,* and **Figure 9**, *Conceptual plan for Alternative SOIL/SED-4*, below) in addition to the no action alternative (Alternative SOIL/SED-1). More details on the cleanup alternatives for soil and sediments are as follows:

Alternative SOIL/SED-1: No action alternative

Capital Cost	$0
Annual O&M Cost	$0
Present Worth Cost	$0
Construction Time	0 years
Time to Achieve RAOs	Not achieved

- As a baseline to compare against other alternatives, no action would be taken to address contamination in the Containment Area, upland soil, wetland soil and sediments, and TMPs in soil. No construction would take place, and RAOs would not be achieved.

Alternative SOIL/SED-2: Containment Area cap, upland soil covers, excavation with off-site disposal and restoration of wetland soil and sediments, limited action for TMPs (Institutional Controls, including vapor intrusion evaluation or vapor barriers/sub-slab depressurization systems)

Capital Cost	$5.6 million
Annual O&M Cost	$1.1 million
Present Worth Cost	$6.1 million
Construction Time	2 years
Time to Achieve RAOs	2 years

- Placement of a permanent cap over the Containment Area, the design and footprint of which will be based on sampling results, including the results of the 2019 Containment Area investigation;[11]
- Closure of the existing equalization window by grouting in place;
- Placement of a soil or asphalt cover system over areas of shallow (0-1 ft) upland soil with concentrations of Site contaminants in excess of the PRGs;
- Excavation of wetland soil and sediment (0-1 ft) with concentrations of Site contaminants in excess of the PRGs;
- Post-excavation confirmatory sampling to document limits of impacts and confirm achievement of RAOs and PRGs;
- Off-site disposal of all excavated material at an appropriate off-site permitted facility; and
- Limited action for TMPs (Institutional controls, including vapor intrusion evaluations or vapor barriers/sub-slab depressurization systems).

Alternative SOIL/SED-3: Containment Area cap, excavation (0-1 ft) with off-site disposal and clean soil cover for upland soil, excavation with off-site disposal and restoration of wetland soil and sediments, air sparging and SVE for TMPs alternative

Capital Cost	\$6.7 million
Annual O&M Cost	\$1.5 million
Present Worth Cost	\$7.5 million
Construction Time	2 years
Time to Achieve RAOs	2 years

- Placement of a permanent cap over the Containment Area, the design and footprint of which will be based on sampling results, including the results of the 2019 Containment Area investigation (see above);
- Closure of the existing equalization window by grouting in place;
- Excavation of upland soil from 0-1 ft with concentrations of Site contaminants in excess of the PRGs;
- Backfilling of excavations with either a 1-ft soil layer cover system or a combination 9-in soil layer and 3-in asphalt layer cover system;
- Excavation of wetland soil and sediment (0-1 ft) with concentrations of Site contaminants in excess of the PRGs;
- Installation and operation of an air sparging/SVE system to remove and treat TMPs in soil;
- Post-excavation confirmatory sampling to document limits of impacts and confirm achievement of RAOs and PRGs; and
- Off-site disposal of all excavated material at an appropriate off-site permitted facility.

Alternative SOIL/SED-4: Excavation (0-10 ft) with off-site disposal and clean soil cover for Containment Area and upland soil, excavation with off-site disposal and restoration of wetland soil and sediments, excavation and off-site disposal for TMPs alternative

[11] Memorandum, *Supplemental Characterization of Containment Area Soil, November 2019, Olin Chemical Superfund Site, 51 Eames Street, Wilmington, MA*, Wood, March 20, 2020.

Capital Cost	$34.0 million
Annual O&M Cost	$330,000
Present Worth Cost	$34.2 million
Construction Time	2 years
Time to Achieve RAOs	2 years

- Excavation of targeted areas within the Containment Area with concentrations of Site contaminants in excess of the PRGs, the extent of which will be based on sampling results, including the results of the 2019 Containment Area investigation (see above);
- Installation of sheet piling, as necessary, to maintain the structural integrity of the slurry wall during excavation;
- Excavation of upland soil from 0-10 ft with concentrations of Site contaminants in excess of the PRGs;
- Excavation of wetland soil and sediment (0-1 ft) with concentrations of Site contaminants in excess of the PRGs;
- Excavation of soil with TMP impacts in excess of the PRGs;
- Dewatering and stabilization of soil, as necessary;
- Post-excavation confirmatory sampling to document limits of soil impacts and confirm achievement of RAOs and PRGs; and
- Off-site disposal of all excavated material at an appropriate off-site permitted facility.

D. ADDITIONAL COMPONENTS UNDER THE ACTION ALTERNATIVES

The following components are also included with each of the above "action" (as opposed to "no action") alternatives:

- Pre-design investigations and/or treatability studies during the Remedial Design (RD) process to:
    - determine the final number, location, and configuration of extraction wells and other remedial components;
    - determine appropriate locations for discharge of treated groundwater to surface water; and
    - facilitate the implementation of the chosen cleanup alternatives and map the precise extent of excavation limits;
- Restoration with native vegetation any wetland or floodplain habitat altered by the remedial action, as well as restoration of any excavated or otherwise altered areas with clean (i.e., compliant with appropriate screening levels), imported backfill to grade and re-vegetation with native vegetation so as to control erosion;
- Long-term maintenance and monitoring of any new and existing remedy infrastructure components;
- Long-term monitoring of the groundwater plume and surface water, to evaluate remedy effectiveness;
- Continued studies to address remaining data gaps, including an improved characterization of bedrock topography and further delineation of the horizontal and vertical extent of groundwater contamination;

- Evaluation of long-term groundwater cleanup options, leading to the selection of a final cleanup plan for the Site;
- Institutional Controls to 1) prohibit future residential use at the Olin property;[12] 2) prohibit the use of groundwater in the OU3 groundwater study area (for example, for potable or irrigation purposes, or for industrial process water) unless it can be demonstrated to EPA, in consultation with the State, that such use will not pose an unacceptable risk to human health and the environment, cause further migration of the groundwater contaminant plume, or interfere with the remedy;[13] 3) prevent disturbance of any engineered systems and any other new and existing remedy infrastructure components; 4) prevent contact with soil beneath cover systems; and 5) require either a vapor intrusion evaluation or vapor mitigation system be installed if a new building is constructed on the Olin property[14] (examples of Institutional Controls include Notice of Activity and Use Limitation (NAUL), Grant of Environmental Restriction and Easement (GERE), town ordinance, advisories, building permit requirements, and other administrative controls); and
- Periodic five-year reviews to assess remedy protectiveness.

V. THE NINE CRITERIA FOR CHOOSING A CLEANUP PLAN

EPA uses nine criteria to evaluate cleanup alternatives and select a final cleanup plan:

1. Overall protection of human health and the environment: Will it protect people and the plant and animal life on and near the site? EPA will not choose a cleanup plan that does meet this basic criterion.

2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs): Does the alternative meet all federal environmental and state environmental and facility siting statutes and regulations that are either applicable or relevant and appropriate to the selected cleanup plan? The cleanup plan must meet this criterion.

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[12] The human health risk assessment for the Site (see 2015 OU1/OU2 RI Report) did not quantify the future exposure risk to potential residents of the Olin property. Therefore, this potential exposure pathway was evaluated by EPA to determine whether the FS needed to address these exposure scenarios should site use change. EPA's evaluation concluded that residential users would have an unacceptable risk from exposure to OU1/OU2 soil at the Site if the site use changed (see Memorandum, *Residential Human Health Risk Evaluation – Olin OU1/OU2 Soils,* Bluestone Environmental Group, January 17, 2020. The unacceptable resident risk [ingestion, dermal contact, and inhalation of airborne dusts] is due to contaminants in soil, including benzo(a)pyrene and other PAHs.). Therefore, the FS includes Institutional Controls to prohibit future residential use of OU1/OU2 soil, which would effectively ensure foreseeable use remains industrial or commercial. Accordingly, PRGs were not developed to address human health risks to future on-Property residents from exposure to contaminated soil.

[13] The Institutional Controls for groundwater will be applied to the area generally presented in **Figure 10**, *OU3 Groundwater Study Area and Extent of Groundwater Institutional Controls,* but may be modified (expanded or decreased) based on new data or information (for example, nature of use of proposed well) and will be effective until final groundwater cleanup goals are selected and achieved in the final remedy for the Site.

[14] The Institutional Controls to require vapor intrusion evaluations and/or vapor mitigation systems for new buildings constructed on the Olin property is the primary method under Alternative SOIL/SED-2 by which TMP contamination in soils is addressed. However, these same controls are components of Alternatives SOIL/SED-3 and -4, though these two alternatives primarily address TMP contamination in soils via active methods (air sparging and SVE, and excavation and off-site disposal, respectively).

3. Long-term effectiveness and permanence: Will the effects of the cleanup plan last or could contamination cause future risk?

   EPA evaluates the long-term effectiveness and permanence of the remedial alternatives from two perspectives: the magnitude of the residual risks and the adequacy and reliability of the controls.

4. Reduction of toxicity, mobility, or volume (TMV) through treatment: Using treatment, does the alternative reduce the harmful effects of the contaminants, the spread of contaminants, and the amount of contaminated material?

   EPA evaluates the degree of reduction of contaminant TMV through treatment for the remedial alternatives from six perspectives: the treatment process used and materials treated, the amount of hazardous materials removed or treated, the reduction in TMV through treatment, the degree to which the treatment is reversible, the type and quantity of residuals remaining after treatment, and whether the alternative satisfies the statutory preference for treatment.

5. Short-term effectiveness: How soon will site risks be adequately reduced? Could the cleanup cause short-term hazards to workers, residents, or the environment?

   EPA evaluates the short-term effectiveness of the remedial alternatives from four perspectives: the risks to the community during implementation, the risks to on-site workers during implementation, short-term environmental impacts, and the time until RAOs are achieved.

6. Implementability: Is the alternative technically feasible? Are the right goods and services (*i.e.* treatment equipment, space at an approved disposal facility) available?

   EPA evaluates the implementability of the remedial alternatives from nine perspectives: the ability to construct and operate the technology, the reliability of the technology, the ease of implementing future remedial actions, if needed, the ability to monitor effectiveness of the remedy, the ability to obtain approvals from other agencies, coordination with other agencies, the ability of off-site treatment, storage, and disposal services, the availability of necessary equipment and specialists, and the availability of prospective technologies.

7. Cost: What is the total cost of an alternative over time? EPA must select a cleanup plan that provides necessary protection for a reasonable cost.

8. State acceptance: Do state environmental agencies agree with EPA's proposal?

9. Community acceptance: What support, objections, suggestions, or modifications did the public offer during the comment period?

VI. OVERVIEW – CLEANUP ALTERNATIVES COMPARISONS

For each of the three sets of consolidated cleanup components, the four alternatives were compared to identify how well each alternative meets EPA's evaluation criteria (see **Table 3**, *Comparative Analyses of Remedial Alternatives*, below). The comparative analysis of alternatives is intended to present advantages and disadvantages of each alternative with respect to each other to aid in the selection of a preferred remedial alternative. In accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and the *Interim-Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA, 1988)*, the overall protection of human health and the environment and compliance with ARARs are threshold criteria that must be met for an alternative to be eligible for selection. Comparative evaluations of the other five balancing criteria identify the relative advantages and disadvantages of each alternative. The State and Community Acceptance criteria (Numbers 8 and 9, respectively, see above) will be evaluated once feedback is received during the public comment period.

The following discussions and tables present a general and cost comparison summary of the alternatives against EPA's evaluation criteria for each of the three cleanup components. More details and supporting information on the specifics of each alternative may be found in Volumes I and II of the FS report.

VII. CLEANUP ALTERNATIVES COMPARISONS – DAPL AND GROUNDWATER HOT SPOTS

The RAOs for the interim DAPL and Groundwater Hot Spot actions are as follows:

- DAPL
  - Reduce, to the extent practicable, the volume of DAPL and mass of contaminants in DAPL that represent a source to groundwater, surface water, and sediments.
  - Reduce, to the extent practicable, the horizontal and vertical migration of DAPL acting as a source of Site contaminants, including penetration into bedrock.
  - Prevent potential human exposure by a future resident to DAPL containing Site contaminants at levels that pose an unacceptable risk.
- Groundwater Hot Spots
  - Reduce, to the extent practicable, the mass of Site contaminants in highly contaminated groundwater (groundwater hot spots).
  - Reduce, to the extent practicable, the further horizontal and vertical migration of Site contaminants in groundwater hot spots, including penetration into bedrock.
  - Prevent potential human exposure by a future resident to groundwater containing Site contaminants at levels that pose an unacceptable risk.

i. Overall Protection of Human Health and the Environment

The No Action Alternative (DAPL/GWHS-1) provides no protection of human health or the environment. This alternative would not reduce the potential for human exposure to DAPL or contaminated Site groundwater. No controls would be put in place to prevent human exposure to groundwater containing Site contaminants above levels that pose an unacceptable risk. No controls would be put in place on DAPL or groundwater migration; remaining DAPL would be a continuing source of contamination to the aquifer, and highly contaminated groundwater hot spots would continue to migrate, causing potential plume expansion and impacts to downgradient groundwater and surface water.

Alternatives DAPL/GWHS-2 through -4 are protective of human health and the environment. These alternatives remove uncontrolled DAPL sources, a major source of contamination to downgradient groundwater, and prohibit the use of groundwater in the OU3 groundwater study area (for example, for potable or irrigation purposes, or for industrial process water) unless it can be demonstrated to EPA, in consultation with the State, that such use will not pose an unacceptable risk to human health and the environment, cause further migration of the groundwater contaminant plume, or interfere with the remedy via Institutional Controls until cleanup goals are met. Groundwater hot spot extraction and treatment is included in these alternatives, which reduces risk to potential downgradient receptors by capturing highly contaminated groundwater that would otherwise migrate uncontrolled and that acts as a source of contamination.

ii. Compliance with ARARs

The remedial action alternatives for DAPL and Groundwater Hot Spots are interim actions that will be evaluated against the RAOs specified above. As interim actions, these alternatives are not expected to attain chemical-specific ARARs, and thus cleanup goals have not been set for these groundwater actions based on chemical-specific ARARs. The achievement of chemical-specific ARARs in groundwater within the aquifer will be addressed in the final remedial action that addresses the restoration of groundwater. The proposed interim remedial actions for groundwater will support the final groundwater remedial action.

No activities would be performed under the No Action Alternative (DAPL/GWHS-1), therefore, action- and location-specific ARARs do not apply.

With proper implementation, it is anticipated that Alternatives DAPL/GWHS-2 through -4 would meet action- and location-specific ARARs. Action-specific ARARs would be met for the treatment and disposal/discharge of extracted DAPL and groundwater. Each alternative may have unavoidable impacts to wetlands and floodplains in the Maple Meadow Brook Wetlands (MMBW) so that extraction wells and piping, and access roads and staging areas for such wells and piping, can be installed. However, these alternatives will comply with location-specific ARARs, which will require minimization of impacts and mitigation of damage for wetlands and floodplains impacted by well installation and piping, and restoration of flood storage capacities, if necessary, following completion of the proposed remedial activities. EPA must make a determination that the cleanup activities in the selected remedial alternative that impact wetland areas are the least environmentally damaging practicable alternative and that there is no practicable alternative to altering floodplain resources for any activities that result in the occupancy and modification of the 100- or 500-year floodplain.

iii. Long-Term Effectiveness and Permanence

The No Action Alternative (DAPL/GWHS-1) would not decrease the risks to human health and the environment. This alternative will have the highest residual risk due to lack of Institutional Controls or plume containment.

Alternatives DAPL/GWHS-2 through -4 rely on Institutional Controls to prevent exposure to contaminated groundwater and use groundwater hot spot and DAPL extraction to intercept the plume and remove source material, thus reducing contaminant toxicity and mobility. Of these three alternatives, Alternatives DAPL/GWHS-3 and -4 are expected to have good long-term effectiveness and permanence and would be more effective in the long-term than Alternative DAPL/GWHS-2, as the former will achieve the removal of an estimated 5% more DAPL (an estimated 14.8 million gallons of DAPL for Alternatives DAPL/GWHS-3 or -4 as compared to an estimated 14.1 million gallons of DAPL for Alternative DAPL/GWHS-2) by using more extraction wells to reduce the number of isolated low points within the DAPL pools, which further reduces residual risk.

Alternative DAPL/GWHS-4 would be somewhat more effective in the long-term than Alternative DAPL/GWHS-3, which would be more effective than Alternative DAPL/GWHS-2, as Alternative DAPL/GWHS-4 targets the lowest groundwater NDMA concentrations (the 1,100 ng/L NDMA contour, versus the 5,000 ng/L NDMA contour targeted by Alternative DAPL/GWHS-3 and the 11,000 ng/L NDMA contour targeted by Alternative DAPL/GWHS-2) and thus leaves the smallest mass of contamination unaddressed and provides the most control over groundwater contaminant sources and migration.

iv. Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment

The No Action Alternative (DAPL/GWHS-1) does not include any treatment, and thus provides no reduction in TMV through treatment. All of the remaining alternatives provide for treatment of DAPL and groundwater contamination.

Alternatives DAPL/GWHS-2 through -4 provide for DAPL extraction from the subsurface, reducing its mobility and volume. DAPL treatment would remove Site contaminants and reduce the volume of DAPL to an estimated 20% of its original volume. DAPL treatment processes would include lime precipitation for metals, dewatering of sludges, stripping of ammonia and volatile organic compounds (VOCs), ultra-violet (UV) photo-oxidation for NDMA, and evaporation of remaining water and off-site disposal of the resulting residual solids. Of the three action alternatives, Alternatives DAPL/GWHS-3 and -4 provide for a greater reduction of contaminant TMV through treatment as compared to Alternative DAPL/GWHS-2 because more DAPL would be removed (an estimated 14.8 million gallons under Alternatives DAPL/GWHS-3 or -4 versus an estimated 14.1 million gallons under Alternative DAPL/GWHS-2), resulting in a smaller amount of DAPL remaining in the subsurface following extraction.

Alternatives DAPL/GWHS-2 through -4 also provide for extraction of hot spot groundwater, which would be treated with a hypochlorite flash mixer, breakpoint chlorination, sediment removal and consolidation, GAC, UV photo-oxidation, and dewatering of solids. Of the three action alternatives, Alternatives DAPL/GWHS-3 and -4 provide for the best reduction of contaminant TMV through treatment as compared to Alternative DAPL/GWHS-2 because a greater volume of contaminated groundwater will be removed and treated (an estimated 68.4 million gallons under Alternative DAPL/GWHS-3 and an estimated 110.3 million gallons under Alternative DAPL/GWHS-4 versus an estimated 17.1 million gallons under Alternative DAPL/GWHS-2). Alternatives DAPL/GWHS-3 and -4 will remove a greater mass of NDMA (an estimated 7,320 g for Alternative DAPL/GWHS-4 and an estimated 7,013 g for Alternative DAPL/GWHS-3) than Alternative DAPL/GWHS-2 (an estimated 4,159 g) from overburden groundwater and the DAPL pools.[15] These two alternatives

[15] EPA has calculated a total NDMA mass of 4,813 g to be present within overburden groundwater at concentrations above 1.1 ng/L NDMA and the three DAPL pools (Containment Area, Jewel Drive, and Main Street). EPA's calculations for the three action alternatives yield an NDMA mass removal of 2,308 g for Alternative DAPL/GWHS-2, 4,125 g for Alternative DAPL/GWHS-3, and 4,595 g for Alternative DAPL/GWHS-4. These calculations show the greater effectiveness of Alternatives DAPL/GWHS-3 and -4 as compared to Alternative DAPL/GWHS-2. While Olin has not completed a similar calculation that compares the effectiveness of the action alternatives in removing NDMA present in overburden groundwater

address the largest volumes of groundwater, resulting in the most control over groundwater migration of all the alternatives considered, however, extraction and treatment of the largest volume of groundwater will result in the largest volume of treatment residuals requiring disposal, as compared to Alternative DAPL/GWHS-2.

Generally, the treatment technologies associated with DAPL and hot spot groundwater are well-proven and irreversible, however, for DAPL, additional design work and treatability studies will take place during the pre-design investigation (PDI) stage to finalize the design of the on-site treatment process. Overall, Alternatives DAPL/GWHS-3 and -4 provide for the highest reductions of contaminant TMV through treatment, and Alternative DAPL/GWHS-2 provides for a lower reduction.

v. Short-Term Effectiveness

While the No Action Alternative (DAPL/GWHS-1) will not be effective in the short-term in protecting human health or the environment, because no remedial activities will occur, there will be no adverse impacts to the public or workers performing the cleanup, or the environment.

Of the three action alternatives, Alternative DAPL/GWHS-2 would be somewhat more effective in the short-term than Alternative DAPL/GWHS-3, which would be more effective than Alternative DAPL/GWHS-4, as the number of extraction wells increases under succeeding alternatives, with increasing impacts to the environment from well drilling and associated construction activities and piping installations (an estimated 7-8 wells, 26 wells, and 32 wells under Alternatives DAPL-GWHS-2, -3, and -4, respectively).

All of these alternatives are expected to pose minimal risk to the community from well drilling and associated general construction activities, treatment of DAPL and hot spot groundwater, and transport and disposal of residual wastes. Limited short-term impacts to the community would include an increase in traffic during construction activities, but these would be minimized as much as possible via use of Best Management Practices (BMPs). These alternatives also pose low risk to workers from exposure to collected DAPL, hot spot groundwater, and treatment residuals. Generally, risks to workers and the community would be minimized via use of BMPs.

The estimated timeframe to remove DAPL under Alternative DAPL/GWHS-2 is approximately 20 years; under this alternative an estimated two to three years would be required to address the target NDMA groundwater concentration of 11,000 ng/L. The estimated timeframe to remove DAPL under Alternatives DAPL/GWHS-3 or -4 is approximately five years; under both alternatives an estimated six to eight years would be required to address the target NDMA concentrations of 5,000 ng/L and 1,100 ng/L, respectively. However, for these three alternatives, the risk of human exposure to DAPL and contaminated groundwater is expected to be addressed upon implementation of Institutional Controls.

Construction of the DAPL and groundwater hot spot extraction and treatment system is expected to have low impacts to the community and workers, as the work may be conducted on the Olin property or within the bounds of other secured property nearby, BMPs will be used to mitigate any issues, and

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at concentrations above 1.1 ng/L, EPA presumes that using Olin's estimates of NDMA mass removal for the three action alternatives for DAPL and groundwater hot spots would yield a similar finding.

construction is estimated to be completed within three months. Installation of new wells and infrastructure is expected to have minor, short-term impacts to the environment; no environmentally sensitive areas have been identified in the likely areas of intrusive work for DAPL, however, all of the action alternatives include one or more extraction wells and piping in the MMBW to collect hot spot groundwater. All of the action alternatives include piping systems in MMBW, with the MMBW piping systems under Alternatives DAPL/GWHS-3 and -4 the most extensive. However, for these three action alternatives, wells and piping would be installed in a manner so as to minimize impacts, and use of BMPs during the work would also serve to minimize environmental impacts in this sensitive area.

vi. Implementability

The No Action Alternative (DAPL/GWHS-1) is the easiest to implement because no remedial activities are required. The remaining alternatives all use standard construction equipment and there are no infrastructure issues; no issues are anticipated regarding the availability of treatment, storage, and disposal facilities (TSDFs) for waste solids and other treatment residuals. Alternatives DAPL/GWHS-2, 3, and 4 would all require access to private property to install extraction wells and conveyance pipes. DAPL and groundwater extraction is a reliable technology and allows for optimization, increasing the reliability.

Implementation of Alternatives DAPL/GWHS-3 and -4 would be more challenging because these alternatives require the placement of groundwater extraction wells directly above the DAPL pools to extract hot spot groundwater. Due to the geochemical properties of DAPL, the extraction of overlying hot spot groundwater must be implemented in a way that minimizes mixing, which could result in the precipitation of dissolved metals that foul the extraction well screens. Potential extraction sequencing and/or cycling strategies, and/or alternative well designs would need to be explored during the pre-design investigation phase and incorporated into the RD to improve the efficiency of groundwater hot spot extraction. Designs to be investigated would include, but are not limited to, the use of short-screened extraction wells to remove DAPL, designed to maximize the distance between the target intake depth and the DAPL/hot spot groundwater interface. A goal of the pre-design investigation would be to determine sufficient spacing between extraction wells to minimize the effects of pumping drawdown, which may allow multiple wells to operate simultaneously while minimizing disturbance of the DAPL and impacts to hot spot groundwater extraction. Positive outcomes would include the achievement of uniform decline in the DAPL pools and a shorter time for DAPL and hot spot groundwater recovery.

DAPL extraction has been implemented at the Site and proven effective and sustainable at a pumping rate of 0.25 gallons per minute (gpm), however, the feasibility of on-site DAPL treatment will require treatability (bench-scale) testing as part of a PDI. The DAPL treatment train will be complex, has unconfirmed effectiveness, and may be less reliable than treatment of hot spot groundwater. Planned monitoring of DAPL and groundwater hot spots will confirm system effectiveness, however, the ability to monitor remedy effectiveness for Alternative DAPL/GWHS-4 is more difficult, as there are fewer monitoring wells available north of the Olin property which would be necessary to gauge effectiveness of this alternative in targeting the groundwater 1,100 ng/L NDMA contour.

Institutional Controls under all three action alternatives can be administratively challenging, however, they can be implemented and completed quickly with adequate planning.

The additional extraction wells under Alternative DAPL/GWHS-4 (an estimated 32 wells total, as compared to an estimated 26 wells under Alternative DAPL/GWHS-3) may pose installation challenges. Overall, of the three action alternatives, Alternatives DAPL/GWHS-2 and -3 have high implementability and the implementability of Alternative DAPL/GWHS-4 is somewhat lower.

vii. Costs

The costs for all alternatives are presented in **Table 3**, *Comparative Analyses of Remedial Alternatives*, below. Except for the costs of the five-year reviews, there is no cost associated with the No Action Alternative (DAPL/GWHS-1). The overall costs for Alternatives DAPL/GWHS-2, -3, and -4 are $22.5 million, $35.5 million, and $40.5 million, respectively.

Alternative DAPL/GWHS-2 has the lowest capital costs ($10.3 million, as compared to $15.6 million for Alternative DAPL/GWHS-3 and $19.3 million for Alternative DAPL/GWHS-4) but O&M costs of over $20 million, which is comparable to the O&M costs of Alternatives DAPL/GWHS-3 and -4. Of Alternatives DAPL/GWHS-2 and -3, Alternative DAPL/GWHS-2 has the lower capital costs, O&M costs, and overall costs.

VIII. CLEANUP ALTERNATIVES COMPARISONS – LNAPL AND SURFACE WATER

The RAOs for the final LNAPL and Surface Water actions are as follows:

- LNAPL
  - Prevent migration of LNAPL to East Ditch Stream to prevent exposure by current and future ecological receptors to Site contaminants that would result in potential adverse impacts.
  - Remove, to the extent practicable, LNAPL that represents a source of Site contaminants to groundwater and a source of TMPs to indoor air vapors, via a vapor intrusion pathway, that pose an unacceptable risk to future indoor workers or building occupants.
- Surface Water
  - Prevent migration of groundwater containing Site contaminants to East Ditch Stream, South Ditch Stream, and Off-Property West Ditch Stream to prevent exposure by current and future ecological receptors to surface water containing Site contaminants that would result in potential adverse impacts.
  - Prevent migration of groundwater containing Site contaminants to Off-Property West Ditch Stream to prevent potential human exposure by a current or future trespasser to surface water containing Site contaminants at levels that pose an unacceptable risk.

i. Overall Protection of Human Health and the Environment

The No Action Alternative (LNAPL/SW-1) provides no protection of human health and the environment. No action would be taken to address residual LNAPL, which would result in ongoing releases to East Ditch Stream. In addition, no actions would be taken to stop the overburden groundwater contaminant plume from continuing to impact East, South, and Off-Property West Ditch Streams. These releases would result in ongoing adverse impacts to the ecological habitat in and adjacent to these streams.

Alternatives LNAPL/SW-2 and -3 are protective of human health and the environment. Both utilize MPE wells to extract LNAPL and contaminated groundwater, preventing the release of LNAPL into East Ditch Stream, as well as using groundwater extraction wells to prevent the overburden groundwater plume from discharging contaminated groundwater into East, South, and Off-Property West Ditch Streams. Both alternatives would include treatment to remove the LNAPL material and Site contaminants from groundwater to levels protective of the streams prior to discharge of extracted groundwater to surface drainage (see Section III(B), above).

Alternative LNAPL/SW-4 is also protective of human health and the environment. This alternative includes excavation and off-site disposal to completely remove the LNAPL, along with continued operation of the three extraction wells along East Ditch Stream, preventing further releases to East Ditch Stream. This alternative also includes the use of targeted PRBs to treat groundwater in-situ to protective levels prior to the groundwater flowing into South and Off-Property West Ditch Streams. This alternative is protective of human health and the environment. Alternative LNAPL/SW-4 would prevent exposure of current and future ecological receptors to surface water containing COCs that would result in potential adverse impacts. Short-term continued operation of Plant B is assumed for this alternative until the new groundwater hot spot treatment system is constructed and operational. At this point, groundwater extracted from the three wells along East Ditch Stream will be re-routed to the new groundwater treatment system. If Plant B were to be shut down prior to construction of the new treatment system, an evaluation of site hydrogeology would be performed first to ensure continued protection of human health and the environment, which might result in the identification of a need for additional extraction wells and/or PRB segments along East Ditch Stream.

ii. Compliance with ARARs

All alternatives, except for the No Action Alternative (LNAPL/SW-1), have been developed to comply with ARARs. There are no chemical-specific ARARs for the LNAPL/SW alternatives. With proper implementation, it is anticipated that Alternatives LNAPL/SW-2 and -3 would meet action- and location-specific ARARs. LNAPL will be removed to the extent practicable, and proposed site-specific surface water PRGs derived from National Recommended Water Quality Criteria (to address ecological risks) and To-Be-Considered (TBC) guidance (to address human health risks) will be used to monitor surface water to ensure that the groundwater extraction and treatment are successful in reducing contaminant levels in surface water to be protective of sensitive receptors. Both alternatives would include treatment to remove the LNAPL material and Site contaminants from groundwater. Under these alternatives, the effluent from the treatment system will be treated prior to any discharges to the streams (see Section IV(D), above). In addition, any impacts to wetlands from the construction of these systems will be mitigated, thus meeting location-specific ARARs.

With proper implementation, it is anticipated that Alternative LNAPL/SW-4 would also meet action- and location-specific ARARs. This alternative includes excavation and off-site disposal to completely remove the LNAPL, along with continued operation of the three extraction wells along East Ditch Stream, preventing further releases to East Ditch Stream. Proposed site-specific ecological surface water PRGs derived from National Recommended Water Quality Criteria will be used to monitor surface water to ensure that the PRBs and extraction wells are successful in reducing contaminant levels in surface water to be protective of ecological receptors. PRBs would also treat groundwater to protective levels prior to groundwater flowing into the streams. In addition, any impacts to wetlands from the construction of these systems will be mitigated (thus achieving location-specific ARARs).

iii. Long-Term Effectiveness and Permanence

The No Action Alternative (LNAPL/SW-1) would not decrease the risks to human health and the environment.

Alternatives LNAPL/SW-2 and -3 would be effective in the long-term as they both would utilize MPE to remove free-phase LNAPL and reduce contaminant levels in the smear zone. Under these alternatives, groundwater containing Site contaminants that would otherwise enter the streams would be permanently removed and treated. Both alternatives would result in some residual risk as neither can remove all LNAPL from soil pores and LNAPL sorbed to soil particles. However, Alternative LNAPL/SW-3 would be more effective in the long-term than Alternative LNAPL/SW-2, with an estimated three to five MPE wells versus an estimated one well under Alternative LNAPL/SW-2, as the expanded MPE system under Alternative LNAPL/SW-3 would remove more of the LNAPL that is located under the Plant B building and result in less residual risk. Under Alternative LNAPL/SW-3, approximately 90% of an estimated 12 gallons of mobile (floating) LNAPL would be removed. By contrast, under Alternative LNAPL/SW-2, an approximately 65% of the mobile LNAPL would be removed. Alternative LNAPL/SW-4 would be the most effective in the long-term, as nearly all residual LNAPL would be removed by excavation.

The MPE and groundwater extraction and treatment systems in Alternatives LNAPL/SW-2,-3, and -4 would permanently remove and treat groundwater containing Site contaminants that would otherwise enter the streams. However, in order to have long-term effectiveness, continuous efforts to operate the systems are required. For Alternative LNAPL/SW-4, the PRBs would convert the contaminants to less toxic contaminants. The PRBs would not require any day-to-day operation and maintenance; however, over time the reactive media within the barrier may become spent and require replacement.

Except for the No Action Alternative (LNAPL/SW-1), all of the alternatives include Institutional Controls to prevent exposure while the remedy is implemented.

iv. Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment

The No Action Alternative (LNAPL/SW-1) does not include any treatment, and thus provides no reduction in TMV through treatment. Alternatives LNAPL/SW-2 and -3 provide for a permanent removal of Site contaminants in groundwater through treatment. Alternative LNAPL/SW-2, utilizing one MPE well, is estimated to capture eight gallons of mobile LNAPL (65% of the estimated 12 gallons of mobile LNAPL), which would be sent off-site for disposal. This alternative also includes collection and treatment of soil vapor and groundwater from one MPE well. Groundwater treatment is irreversible, however, there are waste materials from the treatment system including solids from the filter press and used activated carbon. Alternative LNAPL/SW-3 provides for more reduction of TMV, as it utilizes five MPE wells to capture and treat soil vapor and groundwater. This alternative is estimated to capture 11 gallons of mobile LNAPL (90% of the estimated 12 gallons of mobile LNAPL), including material under Plant B, which will be taken off-site for disposal. Metrics to govern the termination of MPE will be determined during the pre-design investigations. Again, the groundwater treatment is irreversible and similar waste materials would be generated. Alternative LNAPL/SW-4 includes the excavation of 390 tons of soil. This soil will not be treated and may require disposal as hazardous waste. This alternative also utilizes PRBs and the three existing extraction wells along East Ditch Stream to treat groundwater, reducing its toxicity, prior to discharge into streams. If Plant B were to be shut down prior to construction of the new groundwater treatment system, an evaluation of site hydrogeology might result in the identification of a need for additional extraction wells and/or PRB segments along East Ditch Stream. After the PRBs have reached their end of useful life, the material (activated carbon and zeolite) would need to be removed and replaced. Overall, Alterative LNAPL/SW-3 provides for the greatest reduction of contaminant TMV through treatment.

v. Short-Term Effectiveness

While the No Action Alternative (LNAPL/SW-1) will not be effective in the short-term in protecting human health or the environment, because no remedial activities will occur, there will be no adverse impacts to the public or workers performing the cleanup, or the environment.

Alternatives LNAPL/SW-2 and -3 are expected to pose minimal risk to the community from O&M and transport of collected LNAPL. These alternatives also pose very low risk to workers and collected LNAPL and treatment residuals can be minimized by use of BMPs. An estimated one year is the timeframe for remediating LNAPL under Alternatives LNAPL/SW-2 through -4. Construction of the groundwater extraction and treatment system is expected to have low impacts to the community and workers, as the work will be conducted on-site, BMPs will be used to mitigate any issues, and construction is estimated to be completed within three months. Installation of new wells and infrastructure is expected to have minor, short-term impacts to the environment; most of the extraction wells will not be located within environmentally sensitive areas. Groundwater extraction and treatment for Alternatives LNAPL/SW-2 through -4 will require resources and material handling for an extended length of time. A 30-year timeframe was used for O&M, monitoring, and cost estimation purposes for the surface water component.

Alternative LNAPL/SW-4 (soil excavation/stabilization and off-site disposal and PRBs and extraction wells to treat groundwater) poses potential risks to the community from releases of vapor as well as structural stability issues in excavating close to the Massachusetts Bay Transportation Authority (MBTA) railroad tracks. BMPs and technical controls (such as sheet piling) would mitigate these issues. Excavated soils and backfill material would be transported through the community, posing a potential risk. Soil excavation also poses the highest risks to workers from direct contact and inhalation of fugitive soil dusts. These issues can be mitigated by the use of BMPs. Overall, this alternative has the greatest possible short-term impacts, though is estimated to be constructed in less than one year. Construction of the PRBs would require material to be transported off-site, but since this alternative is estimated to be for a short duration, the overall impacts to the community are low. Risks to workers during construction of the PRBs are also low and could be minimized using BMPs. However, construction of the PRBs would have significant short-term impacts to the environment as trenching (heavy construction) will occur in sensitive areas. Overall, Alterative LNAPL/SW-3 provides the best short-term effectiveness.

vi. Implementability

The No Action Alternative (LNAPL/SW-1) is the easiest to implement because no remedial activities are required. The remaining alternatives all use standard construction equipment and there are no infrastructure issues. Groundwater extraction and treatment is a reliable technology and allows for optimization, increasing the reliability. The PRBs would require a PDI and bench-scale testing. Once constructed, there is little post-construction flexibility and therefore less reliability compared to groundwater extraction. Groundwater extraction and treatment technologies are readily available. For the PRBs, large quantities of reactive material are needed, requiring extra lead time to ensure adequate supply during implementation. Overall, of the three action alternatives, Alternative LNAPL/SW-3 is the most reliable and easiest to implement.

vii. Costs

The costs for all alternatives are presented in **Table 3**, *Comparative Analyses of Remedial Alternatives*, below. The overall costs for Alternatives LNAPL/SW-2, -3, and -4 are $9 million, $6.6 million, and $9 million, respectively. Except for the costs of the five-year reviews, there is no cost associated with the No Action Alternative (LNAPL/SW-1). Alternative LNAPL/SW-3 has the lowest capital costs and the highest O&M costs. However, this alternative has the lowest overall costs.

IX. CLEANUP ALTERNATIVES COMPARISONS – SOIL AND SEDIMENTS

The RAOs for the final Soil and Sediment actions are as follows:

- OU1/OU2 Soil
  - Prevent potential human exposure by a future resident to soil containing Site contaminants at levels that pose an unacceptable risk.
- Upland Soil (including the Containment Area)
  - Prevent potential human exposure by a future indoor worker or building occupant to indoor air vapors, via a vapor intrusion pathway, containing Site contaminants at levels that pose an unacceptable risk.
  - Prevent exposure by current and future ecological receptors to upland soil containing Site contaminants that would result in potential adverse impacts.
  - Prevent leaching of Site contaminants associated with the Containment Area into groundwater, surface water, and sediments at levels that pose unacceptable risks to human health and the environment.
- Wetland Soil and Sediments
  - Prevent exposure by current and future ecological receptors to wetland soil and sediments containing Site contaminants that would result in potential adverse impacts.
  - Prevent the further migration of wetland soil and sediments containing Site contaminants to nearby wetlands, surface water, drainage features, and adjoining properties that would result in potential adverse impacts.

i. Overall Protection of Human Health and the Environment

Under the No Action Alternative (SOIL/SED-1), no action would be taken to address exposure to soils and leaching of Site contaminants from soil to groundwater in the Containment Area. No action would be taken to address contaminated upland soil, and soil with concentrations of Site contaminants above those allowed for unrestricted use/unrestricted exposure would not be addressed.

No active remediation would occur for any type of soil, and cleanup objectives would not be achieved. Additionally, no action would be taken to address exposure to wetland soil and sediments with concentrations of Site contaminants above cleanup levels. No active remediation would occur, and cleanup objectives would not be achieved. Finally, no action would be taken to address TMPs in soil. No controls would be put in place to prevent human exposure to TMPs. TMPs would remain in place, and no controls would be put in place to prevent migration of TMP vapors.

Alternative SOIL/SED-1 offers no protection of human health and the environment, and risks to current and future users from direct exposure to contaminated soil or soil vapors, as well as ecological receptors, including the American Robin, Marsh Wren, and other insect-eating birds, Short-Tailed Shrew, and benthic invertebrate community, would remain.

All of the other alternatives are expected to provide protection of human health and the environment by eliminating risks to human health from direct exposure to and inhalation of Site contaminants, and eliminating risks to ecological receptors from direct exposure and ingestion. Site Management Plans (SMPs) and Institutional Controls would be incorporated into each of these alternatives to address soil remaining with concentrations above those allowed for unrestricted use/unrestricted exposure, prevent disturbance of remedial measures, and restrict use to commercial/industrial.

Alternative SOIL/SED-2 includes an impermeable cap above the contaminated soil in and near the Containment Area to prevent exposure and minimize leaching of soil contaminants to groundwater. Although the alternative does not involve removal of soil from the Containment Area, the impermeable cover coupled with the slurry wall and closure of the equalization window would serve to minimize leaching.

Alternative SOIL/SED-2 also includes covering all upland soil areas containing elevated levels of Site contaminants above PRGs with clean soil, eliminating the exposure pathway for ecological receptors. The soil covers would include long-term maintenance and repair and would be protected by Institutional Controls to prevent disturbance of these soil covers. Under this alternative, all wetland soil and sediments containing elevated levels of Site contaminants above PRGs would be excavated and disposed of off-site, eliminating future exposures for ecological receptors. The restoration of the excavated wetland soil and sediment to existing grades would prevent the need for further wetland or flood storage mitigation (other than restoring the surface to native wetland/aquatic habitat and restoring any access ways to the excavation areas). Finally, the alternative includes additional vapor intrusion evaluations to assess risks and/or the use of vapor barriers and/or sub-slab depressurization systems if buildings are constructed in areas containing soil contaminated with TMPs at levels that may pose a vapor intrusion risk. Any engineered systems preemptively installed or otherwise determined to be necessary as a result of the vapor intrusion evaluations would prevent the migration of soil vapors into buildings, eliminating future exposures to indoor workers.

Alternative SOIL/SED-3 contains many of the same components as Alternative SOIL/SED-2, except it would handle the upland soil contaminated with Site contaminants above PRGs differently. With the exception of TMPs, soil containing Site contaminants above PRGs would be excavated down to 1 ft, backfilled, and then covered with either clean soil or asphalt, depending on the location. Soil containing TMPs would be treated with air sparging and SVE. These technologies would eliminate exposure pathways for ecological receptors and remove contaminants causing potential vapor intrusion issues.

Alternative SOIL/SED-4 applies excavation to all media. Containment Area and other upland soil containing Site contaminants above PRGs would be excavated down to 10 ft, then covered with clean soil. This alternative would include potential treatment of water generated from excavations or dewatered soils and discharge of treated water to surface water. All wetland soil and sediments containing elevated levels of Site contaminants above PRGs would be excavated and disposed of off-site, eliminating future exposures for ecological receptors. This alternative includes backfilling and restoration of the excavated areas, environmental monitoring, and implementation of Institutional Controls to prohibit excavation or disturbance of these soils and restrict use to commercial/industrial.

All of the alternatives would require five-year reviews, since each would leave contaminated soil in place that exceeds unrestricted use risk standards.

ii. Compliance with ARARs

The No Action Alternative (SOIL/SED-1) would not meet chemical-specific ARARs since it does not prevent exposure to contaminated soil, soil vapors, or sediment. No activities would be performed under Alternative SOIL/SED-1, thus action-specific and location-specific ARARs do not apply to this alternative. With proper implementation, it is anticipated that Alternatives SOIL/SED-2, -3 and -4 would meet action-specific, location-specific, and chemical-specific ARARs.

Alternative SOIL/SED-2 includes an impermeable cap above the Containment Area, covering contaminated upland soil areas with clean soil, excavating contaminated wetland soil and sediments, and conducting vapor intrusion evaluations and/or using vapor barriers and/or sub-slab depressurization systems in new construction in areas with soil containing TMPs at levels that may pose a vapor intrusion risk. The cap for the Containment Area would comply with Resource Conservation and Recovery Act (RCRA) Subtitle D regulations and Massachusetts solid waste management regulations and meet impermeability requirements with an effective permeability that is equivalent to the permeability of the existing slurry wall (approximately 1×10^{-8} centimeters per second (cm/sec)) or a permeability of no greater than 1×10^{-7} cm/sec, whichever is less. Excavated contaminated wetland soil and sediments determined to contain hazardous waste would be managed in accordance with RCRA hazardous waste regulations.

Excavation of contaminated wetland soil and sediments would comply with location-specific ARARs through appropriate avoidance, minimization, mitigation, and restoration. Impacted wetlands would be re-established following completion of remedial activities.

Permanent or temporary wetlands loss and impacts to the 500-year floodplain due to construction of the Containment Area cap, installation of covers in upland soil areas, excavation of wetland soil and sediments, and construction of engineered vapor intrusion mitigation systems would comply with location-specific ARARs through appropriate avoidance, minimization, mitigation, and restoration. Impacted wetlands would be re-established following completion of remedial activities. Upon completion of excavation work in wetlands, erosion blankets would be installed, where applicable, and wetland grass varieties would be seeded. Temporary erosion control BMPs would be instituted until such time as natural systems recover. Plants and visible ground surfaces would be inspected and maintained until plantings are fully established. In the Proposed Plan, EPA must make a determination that the cleanup activities in the selected remedial alternative that impact wetland areas are the least environmentally damaging practicable alternative and that there is no practicable alternative to altering floodplain resources for any activities that result in the occupancy and modification of the 500-year floodplain.

Through its analysis of alternatives, EPA has determined that construction of the Containment Area cap, installation of covers in upland soil areas, excavation of wetland soil and sediments, and construction of engineered vapor intrusion mitigation systems will likely result in temporary occupancy of the 500-year floodplain, but after completion of work there will not be any net loss of flood storage capacity. Additionally, based on the available data, EPA has determined that implementation of these cleanup alternatives will not result in the permanent occupancy and modification of the 500-year floodplain. A stormwater study would be undertaken as part of these alternatives to confirm that this is the case. If temporary impacts to the 500-year floodplain are found to be unavoidable while implementing the alternatives, additional mitigation measures would be incorporated to address temporary alteration of floodplains during remedial construction and any additional floodplain impairment within the 500-year floodplain. Excavated materials would be managed so as to not temporarily impair resources within the 500-year floodplain or adjacent wetlands, to the extent practicable. Upon completion of work in floodplains and wetlands, the impacted areas would be backfilled to original grade with clean soil (i.e., soil that meets appropriate screening levels) and restored with native vegetation.

Alternative SOIL/SED-3 differs from Alternative SOIL/SED-2 only in how the upland soil contaminated with BEHP, chromium, and TMPs is handled (excavation for soils containing BEHP and chromium; and air sparging and SVE to treat TMPs). Soils with concentrations of Site contaminants above PRGs would be removed and managed on-site in compliance with ARARs until disposed of at a permitted, off-site facility. Chemical-specific ARARs were considered in the development of the PRGs for soils and sediments.

Alternative SOIL/SED-4, which applies excavation to all media, will also comply with all ARARs. Soil and sediments with concentrations of Site contaminants above PRGs would be removed and managed on-site in compliance with ARARs until disposed of at a licensed off-site facility. Under this alternative, soil exceeding PRGs (i.e., chromium exceeding 1,000 milligrams per kilogram [mg/kg] and BEHP exceeding 3 mg/kg) within the Containment Area (estimated to be approximately 44,608 cubic yards) would be excavated and disposed of at an approved off-site facility after dewatering and stabilization, as necessary. Excavated areas would then be backfilled with clean soils, which would serve as a cap over areas of remaining subsurface contamination. Due to the depth of the excavation and proximity of excavation areas to the slurry wall, a sheet pile wall would be installed to protect the structural integrity of the slurry wall and the equalization window when excavation occurs near the wall. Although not expected based on available data, any excavated soil that contains hazardous waste because it fails the toxicity characteristic leaching procedure (TCLP), and any excavated soil from below the water table would be treated and stabilized on-site in accordance with ARARs prior to transportation and off-site disposal. Water and any associated air discharges generated from dewatering activities during excavations and the management of excavated soil would meet applicable ARARs for discharge.

In summary, any wastes generated by remedial activities for Alternatives SOIL/SED-2 through -4 would be managed on-site in compliance with ARARs until disposed of at a permitted, off-site disposal facility. Any water generated during soil and sediment excavation and de-watering activities would be characterized and treated appropriately, then either discharged to surface water or disposed of off-site, as appropriate. All work within wetlands and streams would meet action-specific ARARs for protecting water quality.

iii. Long-Term Effectiveness and Permanence

The No Action Alternative (SOIL/SED-1) is the least effective alternative for long-term effectiveness and permanence because risks from Site contaminants in soil and sediments are not addressed. Contaminant concentrations exceeding PRGs would remain, human health and ecological risks would not be addressed, and the process whereby Site contaminants above PRGs leach to groundwater would remain unchanged. Each of the other alternatives has some degree of residual risk due to contamination that will remain on-site and will require five-year reviews to assess the ongoing protectiveness of the remedy and Institutional Controls to prevent exposure to the remaining contamination. Alternatives SOIL/SED-2 and -3 are comparably effective in the long-term, while Alternative SOIL/SED-4 would be the most effective in the long-term, as this alternative provides for removal of the greatest quantities of contaminated soil and contamination that is furthest from the surface than either Alternatives SOIL/SED-2 or -3.

Alternatives SOIL/SED-2 through -4 include the same approach to remediating wetland soil and sediments: excavation to a depth of one ft, followed by backfilling with clean wetland soil and sediment, as appropriate and in accordance with a wetland restoration plan, and restoration to original grades, which will be highly protective of human and ecological receptors. Long-term effectiveness is dependent on the adequacy of the hydric soil (soil that is sufficiently wet to create anaerobic conditions, as is found in wetlands), the success of the wetland plantings, environmental monitoring, and Institutional Controls.

Alternatives SOIL/SED-2 and -3 include a permanent, impermeable cap over the Containment Area and closure of the equalization window. These actions would help to hydraulically isolate the impacted soils, reduce the potential for contaminants to leach and migrate, and therefore control the exposure to contaminants remaining in place. Some residual risk would remain for the soil remaining in place beneath the permanent cap, which would be addressed via Institutional Controls. Installation of the cap will help to minimize leaching from impacted soil remaining in place. Institutional Controls would protect the cap, prevent exposure to Site contaminants in soil and soil vapor, and prevent use other than commercial/industrial.

Under Alternative SOIL/SED-2, contaminated upland soil would be covered to eliminate the exposure pathway for ecological receptors, and engineering controls for TMPs would be required for new construction to address potential vapor intrusion risks. Contaminants would remain in place, causing potential future risk if they were to be exposed. Institutional Controls would mitigate these risks, provided that the controls are maintained. The long-term effectiveness of the soil cover and Institutional Controls to prevent disturbance and require engineering controls to address vapor intrusion would be contingent on maintenance and monitoring of the controls chosen during remedy design.

Treatment of TMPs under Alternative SOIL/SED-3 – via air sparging/SVE – would be less effective in the long-term than the approach taken under Alternative SOIL/SED-2. While vapor capture would effectively control TMPs during treatment and residual risk would be low and mitigated through Institutional Controls, some TMPs would likely remain sorbed to soil and not fully removed.

Under Alternative SOIL/SED-4, which would be most effective in the long-term, excavation would be applied to all media. Excavation and replacement with clean soil would reliably reduce the potential for human health and ecological risk. Some residual risk would remain for the soil that remains (e.g., contaminated soil remaining in the Containment Area that is more than 10 feet deep), but Institutional Controls would prevent exposure to this soil and prevent use other than commercial/industrial. While soil excavation in TMP-impacted areas would have the potential to release vapors and might require additional water handling, these risks would be mitigated via an SMP during implementation.

iv. Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment

No treatment is provided for in the No Action Alternative (SOIL/SED-1), and thus no reduction in TMV through treatment is provided. Alternatives SOIL/SED-2 and -4 provide comparable reductions in contaminant TMV through treatment, while Alternative SOIL/SED-3 provides the highest degree of reduction in contaminant TMV through treatment.

All of the alternatives, with the exception of the No Action Alternative, reduce the mobility of contaminants throughout the Site by providing for their on-site containment, off-site disposal, and/or treatment. However, active treatment is a component of only one alternative – SOIL/SED-3 – via air sparging/SVE. With the exception of this active-treatment approach under Alternative SOIL/SED-3, the components of all of the other alternatives require either caps/covers or excavation and clean soil covers, as opposed to primary treatment, to reduce the TMV of contaminated soil and sediment.

Alternatives SOIL/SED-2 and -4, in addition to the non-TMP components of Alternative SOIL/SED-3, include limited treatment as a component of the alternatives, in that excavated soil or sediment that exhibits a hazardous waste characteristic or soil/sediments that are excavated from below the water table would be treated (stabilized) by adding Portland cement, lime, or another suitable stabilizing agent to reduce contaminant mobility prior to off-site disposal. Additionally, water generated from excavation/dewatering soil prior to off-site disposal would be treated to reduce toxicity prior to discharge to surface waters on-site.

Alternative SOIL/SED-2 includes vapor intrusion evaluations and/or engineering controls, including vapor mitigation features, to prevent human exposure to TMPs in soil. For engineered systems, regular inspections and maintenance would be required to ensure a completed vapor intrusion pathway does not develop. The removal and diversion of soil vapors through natural degradation processes would be considered irreversible, however, TMP mass would remain in place and would not be actively treated by a vapor barrier or sub-slab depressurization system, which are considered passive/semi-passive systems. To achieve protection of human health, this alternative relies on the implementation and enforcement of engineering controls and Institutional Controls.

v. Short-Term Effectiveness

While the No Action Alternative (SOIL/SED-1) will not be effective in the short-term in protecting human health or the environment, because no remedial activities will occur, there will be no adverse impacts to the public or workers performing the cleanup, or short-term impacts to natural habitats.

The remaining alternatives (SOIL/SED-2 through -4) all include excavation and consolidation of contaminated soil and sediments, to varying degrees, which will have some short-term impacts or risks that will be mitigated via use of BMPs requiring appropriate Personal Protective Equipment (PPE) during remedial activities, dust control, and proper handling and management of contaminated media and other waste materials. Of these three alternatives, Alternative SOIL/SED-2 would be the most effective in the short-term, Alternative SOIL/SED-3 would be somewhat less effective in the short-term, and Alternative SOIL/SED-4 would be the least effective in the short-term.

Alternative SOIL/SED-2 will require approximately 6,000 tons of contaminated soil and sediments to be transported off-site; Alternative SOIL/SED-3 will require approximately 10,000 tons of material to be transported off-site; and Alternative SOIL/SED-4 will require the transportation of approximately 130,000 tons of material off-site. In terms of risks for the community and on-site workers during implementation, Alternative SOIL/SED-2 incorporates the least amount of contaminated soil and sediment excavation, temporary stockpiling, on-site consolidation, loading, and transportation, while Alternative SOIL/SED-4 incorporates the most amount. These remedial action alternatives provide a means of potential exposure to the nearby community, on-site workers (via fugitive dust or the active work environment), and the nearby environment to contaminated media.

The least amount of soil and sediments is handled by Alternative SOIL/SED-2, which means it creates the least risk to the community, workers, and the environment, while the most amount of material is handled by Alternative SOIL/SED-4, which would create the most risk from these perspectives. Excavation of deeper upland soil under Alternative SOIL/SED-4 may also require excavation support to protect the railroad, which would entail greater risks to workers. Alternative SOIL/SED-4 also includes deep soil excavation, and soil and water management, which pose a high potential for direct contact and vapor exposure compared to the other alternatives. Risks to the community include those from increased transportation of hazardous materials and increased traffic to bring in backfill material, and some of the excavated soil may have contaminated soil vapor, however, BMPs would reduce these risks to the community. Excavation, stabilization, and restoration will require a larger temporary footprint than capping alone, as more space will be needed for staging materials. However, these can be staged away from ecologically sensitive areas.

Short-term impacts to the environment include emissions from on-site equipment, trucks delivering clean soil cover and/or capping materials, and potential transport of excavated material to the on-site consolidation area(s). Every effort will be made to minimize the areas of upland and wetland habitat impacted to access contaminated surface and subsurface soil and sediment for excavation and consolidation, regardless of which alternative is selected, and mitigation measures will be taken to reduce impacts wherever possible. Following excavation, upland and wetland areas will be restored to match original conditions. Short-term environmental impacts are considerable under Alternatives SOIL/SED-3 and -4, but less so under Alternative SOIL/SED-2. The engineering controls and Institutional Controls for TMPs under Alternative SOIL/SED-2 would not pose a risk to the community, construction personnel, or the environment during installation activities. Accomplishing vapor mitigation with an SSDS would require low levels of electrical power, and air/soil gas monitoring would require relatively minimal resources to complete. Installation and operation of air sparging/SVE equipment to treat TMPs under Alternative SOIL/SED-3 has some potential for vapors to escape and poses lower-level risks to workers, which would be addressed via BMPs.

Alternatives SOIL/SED-2 through -4 will all meet the established RAOs for soil and sediments in the same general timeframe, and all will require generally the same amount of time to construct (approximately two years).

vi. Implementability

The No Action Alternative (SOIL/SED-1) would not require any actions to be taken at the Site and therefore does not present any implementability issues. All of the remaining alternatives are relatively comparable given that they involve routine construction work (conventional and available technology), available trained personnel and materials, and, in the case of air sparging/SVE for TMPs under Alternative SOIL/SED-3, a technology that was previously implemented at the Site without any issues related to construction or operation. Overall, of the three action alternatives, Alternative SOIL/SED-2 is the most reliable and easiest to implement.

Excavation and capping/covering are not considered highly complex and have been frequently and readily implemented at similar environmental restoration sites. Of the three action alternatives, Alternative SOIL/SED-2 is comparatively the easiest to implement because of the higher implementability of caps/covers over excavation, as well as the various attributes of the engineering controls which would be used to address risks from TMPs. These include the relative ease of conducting vapor intrusion evaluations and incorporating vapor barriers and SSDSs into new building construction, and the reliability and minimal maintenance associated with engineered systems. Permits are not required to implement the remedy for TMPs under Alternative SOIL/SED-2; however the construction and operation of vapor mitigation systems is highly reliant on Institutional Controls to prevent human contact with hazardous wastes. Coordination with the Town of Wilmington and Massachusetts Department of Environmental Protection (MassDEP) will be necessary to ensure that new construction within zones of TMP impacts properly account for residual risks from TMP vapors.

No difficulties or uncertainties are anticipated with construction of the permanent cap and sealing the equalization window for the Containment Area under Alternatives SOIL/SED -2 and -3. The proposed cap will be reliable if regularly inspected and maintained. Migration of contaminants via leaching is possible, as is also the case for the excavation remedy for the Containment Area under Alternative SOIL/SED-4, under which remaining contamination that is more than 10 ft deep may be a source for groundwater, surface water, and sediment contamination. This concern may be mitigated, however, via the use of monitoring wells both inside and outside the Containment Area to monitor groundwater contaminant concentrations.

Alternatives SOIL/SED-3 and -4 are comparatively more difficult to implement than Alternative SOIL/SED-2 because the former require managing and consolidating the greatest amount of waste and, in the case of Alternative SOIL/SED-4, a possible need for sheet piling for soil structural support in an area near the MBTA railroad tracks where the structural stability of soil may be a concern. All three of these alternatives will result in impacts to wetlands during excavation activities (and for some, placement of caps or covers); such impacts will be minimized to the extent possible and mitigation for unavoidable impacts will be required. Actions will be taken to ensure that current flood storage capacities are not be diminished after completion of the proposed remedial activities. For Alternatives SOIL/SED-2 through -4, coordination with other agencies, as well as monitoring to determine the effectiveness of the remedy, is equally implementable. PDI sampling would be used to ensure that caps/covers are adequately protective and that excavations are complete.

vii. Costs

The costs for all alternatives are presented in **Table 3**, *Comparative Analyses of Remedial Alternatives*, below. Except for the costs of the five-year reviews, there is no cost associated with the No Action Alternative (SOIL/SED-1). The overall costs for Alternatives SOIL/SED-2, -3, and -4 are $6 million, $7.5 million, and $34.2 million, respectively.

Alternative SOIL/SED-2 has the lowest capital costs and O&M costs comparable to those of Alternative SOIL/SED-3, but higher than the O&M costs associated with Alternative SOIL/SED-4. However, due to the high capital costs associated with Alternative SOIL/SED-4 (which raises the overall costs for this alternative significantly over the other alternatives), Alternative SOIL/SED-2 has the lowest overall costs.

X. List of Acronyms

ARARs	Applicable or Relevant and Appropriate Requirements
BEHP	bis-2-ethylhexylphthalate
BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
BMPs	Best Management Practices
CA	Containment Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/s	centimeters per second
DAPL	Dense Aqueous Phase Liquid
DAPL/GWHS	Dense Aqueous Phase Liquid and Groundwater Hot Spots
EPA	United States Environmental Protection Agency
FS	Feasibility Study
ft	foot or feet
GAC	granular activated carbon
gpm	gallons per minute
GWHS	Groundwater Hot Spot
IAFS	Interim Action Feasibility Study
in	inch
LNAPL	Light Non-Aqueous Phase Liquid
LNAPL/SW	Light Non-Aqueous Phase Liquid and Surface Water
MassDEP	Massachusetts Department of Environmental Protection
MBTA	Massachusetts Bay Transportation Authority
mg/kg	milligrams per kilogram
MMBW	Maple Meadow Brook Wetlands
MPE	multi-phase extraction

NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDMA	n-nitrosodimethylamine
ng/L	nanograms per Liter
O&M	operations and maintenance
OPWD	Off-Property West Ditch Stream
OU	Operable Unit
PDI	pre-design investigation
PPE	Personal Protective Equipment
PRB	permeable reactive barrier
PRG	Preliminary Remediation Goal
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RI	Remedial Investigation
ROD	Record of Decision
Site	Olin Chemical Superfund Site
SMP	Site Management Plan
SOIL/SED	Soil and Sediments
WSS	Wetland Soil and Sediment
SSDS	sub-slab depressurization system
SVE	soil vapor extraction
SW	Surface Water
TBC	To-Be-Considered
TCLP	toxicity characteristic leaching procedure
TMPs	trimethylpentenes
TMV	toxicity, mobility, or volume
TSDF	treatment, storage, and disposal facility
UV	ultra-violet
VOCs	volatile organic compounds

Appendix A – Tables

Table 1. Individual Cleanup Components and Remedial Alternatives in Volumes I and II of the FS Report

Individual Cleanup Components	Remedial Alternatives Considered	
DAPL	DAPL-1	No action
	DAPL-A	DAPL pool extraction with approximately five wells total (DAPL-2A for the OPWD[1] DAPL Pool; DAPL-3A for the Containment Area DAPL Pool; and DAPL-4A for the Main Street DAPL Pool)
	DAPL-B	DAPL pool extraction with approximately 20 wells total (DAPL-2B for the OPWD DAPL Pool; DAPL-3B for the Containment Area DAPL Pool; and DAPL-4B for the Main Street DAPL Pool)
Groundwater Hot Spots	GWHS-1	No action
	GWHS-2	Groundwater hot spot extraction with approximately two wells targeting the 11,000 ng/L[2] NDMA[3] contour
	GWHS-3	Groundwater hot spot extraction with approximately three wells targeting the 11,000 ng/L NDMA contour
	GWHS-4	Groundwater hot spot extraction with approximately six wells targeting the 5,000 ng/L NDMA contour
	GWHS-5	Groundwater hot spot extraction with approximately 12 wells targeting the 1,100 ng/L NDMA contour
LNAPL	LNAPL-1	No action
	LNAPL-2	Manual removal (skimmers and absorbent socks)
	LNAPL-3	Continued mechanical recovery (skimmers in additional recovery wells)
	LNAPL-4	MPE[4]
	LNAPL-5	Continued operation of Plant B to capture and treat LNAPL, followed by Plant B demolition and expanded MPE
	LNAPL-6	Excavation and off-site disposal
Surface Water	SW-1	No action
	SW-2	Limited action – surface water and groundwater monitoring
	SW-3	Groundwater extraction and treatment
	SW-4	Targeted groundwater extraction and treatment
	SW-5	PRBs[5]
	SW-6	Targeted approach for PRB installation
Containment Area	CA-1	No action
	CA-2	Capping system
	CA-3	Targeted soil removal

[1] OPWD = Off-Property West Ditch Stream
[2] ng/L = nanograms per Liter
[3] NDMA = n-nitrosodimethylamine
[4] MPE = multi-phase extraction
[5] PRB = permeable reactive barrier

Individual Cleanup Components	**Remedial Alternatives Considered**	
Upland Soil	Soil-1	No action
	Soil-2	Cover systems
	Soil-3	Excavation (0-1 ft[6]) and cover systems
	Soil-4	Excavation (0-10 ft) and off-site disposal
Wetland Soil and Sediments	WSS-1	No action
	WSS-2	Excavation and off-site disposal
TMPs in Soil	TMP-1	No action
	TMP-2	Limited action (Institutional Controls, including vapor intrusion evaluations or vapor barriers and/or sub-slab depressurization systems)
	TMP-3	Air sparging and SVE[7]
	TMP-4	In-situ thermal treatment
	TMP-5	Excavation and off-site disposal

[6] ft = foot

[7] SVE = soil vapor extraction

Table 2. Consolidated Cleanup Components and Remedial Alternatives in Volume III of the FS Report

Consolidated Cleanup Components	**Remedial Alternatives Considered**	
DAPL and Groundwater Hot Spots [DAPL/GWHS]	DAPL/GWHS-1	No action alternative - Formerly DAPL-1 and GW-1
	DAPL/GWHS-2	DAPL extraction (approx. 5 wells), groundwater hot spot extraction targeting 11,000 ng/L NDMA (approx. 2-3 wells), on-site treatment at new treatment system alternative - Formerly DAPL-A and GW-2/3
	DAPL/GWHS-3	DAPL extraction (approx. 20 wells), groundwater hot spot extraction targeting 5,000 ng/L NDMA (approx. 6 wells), on-site treatment at new treatment system alternative - Formerly DAPL-B and GW-4
	DAPL/GWHS-4	DAPL extraction (approx. 20 wells), groundwater hot spot extraction targeting 1,100 ng/L NDMA (approx. 12 wells), on-site treatment at new treatment system alternative - Formerly DAPL-B and GW-5
LNAPL and Surface Water [LNAPL/SW]	LNAPL/SW-1	No action alternative - Formerly LNAPL-1 and SW-1
	LNAPL/SW-2	MPE for LNAPL with treatment at Plant B, groundwater extraction to prevent discharge to surface water, on-site treatment at new treatment system alternative - Formerly LNAPL-4 and SW-3
	LNAPL/SW-3	Demolition of Plant B, expanded MPE for LNAPL, targeted groundwater extraction to prevent discharge to surface water, on-site treatment at new treatment system alternative - Formerly LNAPL-5 and SW-4
	LNAPL/SW-4	Excavation of LNAPL with off-site disposal, targeted PRBs to treat groundwater before discharge into surface water alternative - Formerly LNAPL-6 and SW-6
Soil and Sediments [SOIL/SED]	SOIL/SED-1	No action alternative - Formerly CA-1, Soil-1, WSS-1, and TMP-1
	SOIL/SED-2	Containment Area cap, upland soil covers, excavation with off-site disposal and restoration of wetland soil and sediments, limited action for TMPs (Institutions Controls, including vapor intrusion evaluations or vapor barriers/sub-slab depressurization systems) alternative - Formerly CA-2, Soil-2, WSS-2, and TMP-2

Consolidated Cleanup Components	Remedial Alternatives Considered	
	SOIL/SED-3	Containment Area cap, excavation (0-1 ft) with off-site disposal and clean soil cover for upland soil, excavation with off-site disposal and restoration of wetland soil and sediments, air sparging and SVE for TMPs alternative - Formerly CA-2, Soil-3, WSS-2, and TMP-3
	SOIL/SED-4	Excavation (0-10 ft) with off-site disposal and clean soil cover for Containment Area and upland soil, excavation with off-site disposal and restoration of wetland soil and sediments, excavation and off-site disposal for TMPs alternative - Formerly CA-3, Soil-4, WSS-2, and TMP-5

Table 3. Comparative Analysis of Remedial Alternatives

ALTERNATIVES BY MEDIUM	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Capital Cost	O&M Cost	Total (Net Present Value)
Alternative DAPL/GWHS-1: No action alternative	✕	✕	N/A	N/A	-	++	$0	$0	$0
Alternative DAPL/GWHS-2: DAPL extraction (approx. 5 wells), groundwater hot spot extraction targeting 11,000 ng/L (approx. 2-3 wells), on-site treatment at new treatment system alternative	✓	✓	-	+	+	+	$10,253,755	$21,701,568	$22,518,229
Alternative DAPL/GWHS-3: DAPL extraction (approx. 20 wells), groundwater hot spot extraction targeting 5,000 ng/L (approx. 6 wells), on-site treatment at new treatment system alternative	✓	✓	+	++	+	+	$15,625,318	$24,620,268	$35,497,565
Alternative DAPL/GWHS-4: DAPL extraction (approx. 20 wells), groundwater hot spot extraction targeting 1,100 ng/L (approx. 12 wells), on-site treatment at new treatment system alternative	✓	✓	++	++	-	-	$19,289,931	$26,519,632	$40,464,350
Alternative LNAPL-SW-1: No action alternative	✕	✕	N/A	N/A	-	++	$0	$0	$0
Alternative LNAPL/SW-2: MPE for LNAPL with treatment at Plant B, groundwater extraction to prevent discharge to surface water, on-site treatment at new treatment system alternative	✓	✓	-	+	-	+	$4,638,520	$6,534,000	$9,005,134
Alternative LNAPL/SW-3: Demolition of Plant B, MPE for LNAPL, targeted groundwater extraction to prevent discharge to surface water, on-site treatment at new treatment system alternative	✓	✓	+	++	+	++	$2,278,032	$7,356,000	$6,644,452
Alternative LNAPL/SW-4: Excavation of LNAPL with off-site disposal, targeted PRBs to treat groundwater before discharge into surface waters alternative	✓	✓	++	+	--	-	$5,313,855	$6,726,091	$8,976,238
Alternative SOIL/SED-1: No action alternative	✕	✕	N/A	N/A	-	++	$0	$0	$0
Alternative SOIL/SED-2: Containment Area cap, upland soil covers, excavation with off-site disposal and restoration of wetland soil and sediments, limited action for TMPs (Institutional Controls, including vapor intrusion evaluations or vapor barriers/sub-slab depressurization systems) alternative	✓	✓	+	-	+	++	$5,614,205	$1,127,600	$6,072,515
Alternative SOIL/SED-3: Containment Area cap, excavation (0-1 ft) with off-site disposal and clean soil cover for upland soil, excavation with off-site disposal and restoration of wetland soil and sediments, air sparging and SVE for TMPs alternative	✓	✓	+	+	-	+	$6,686,227	$1,522,200	$7,470,417
Alternative SOIL/SED-4: Excavation (0-10 ft) with off-site disposal and clean soil cover for Containment Area and upland soil, excavation with off-site disposal and restoration of wetland soil and sediments, excavation and off-site disposal for TMPs alternative	✓	✓	++	-	--	+	$34,045,584	$330,400	$34,174,675

Notes:

✕ Fails -- Poor
✓ Passes - Fair
+ Good
++ Very Good

DAPL = Dense Aqueous Phase Liquid
ft = feet
LNAPL = Light Non-Aqueous Phase Liquid
MPE = multi-phase extraction
ng/L = nanograms per Liter
PRB = Permeable Reactive Barrier
SVE = soil vapor extraction
TMPs = trimethylpentenes

Appendix B – Figures

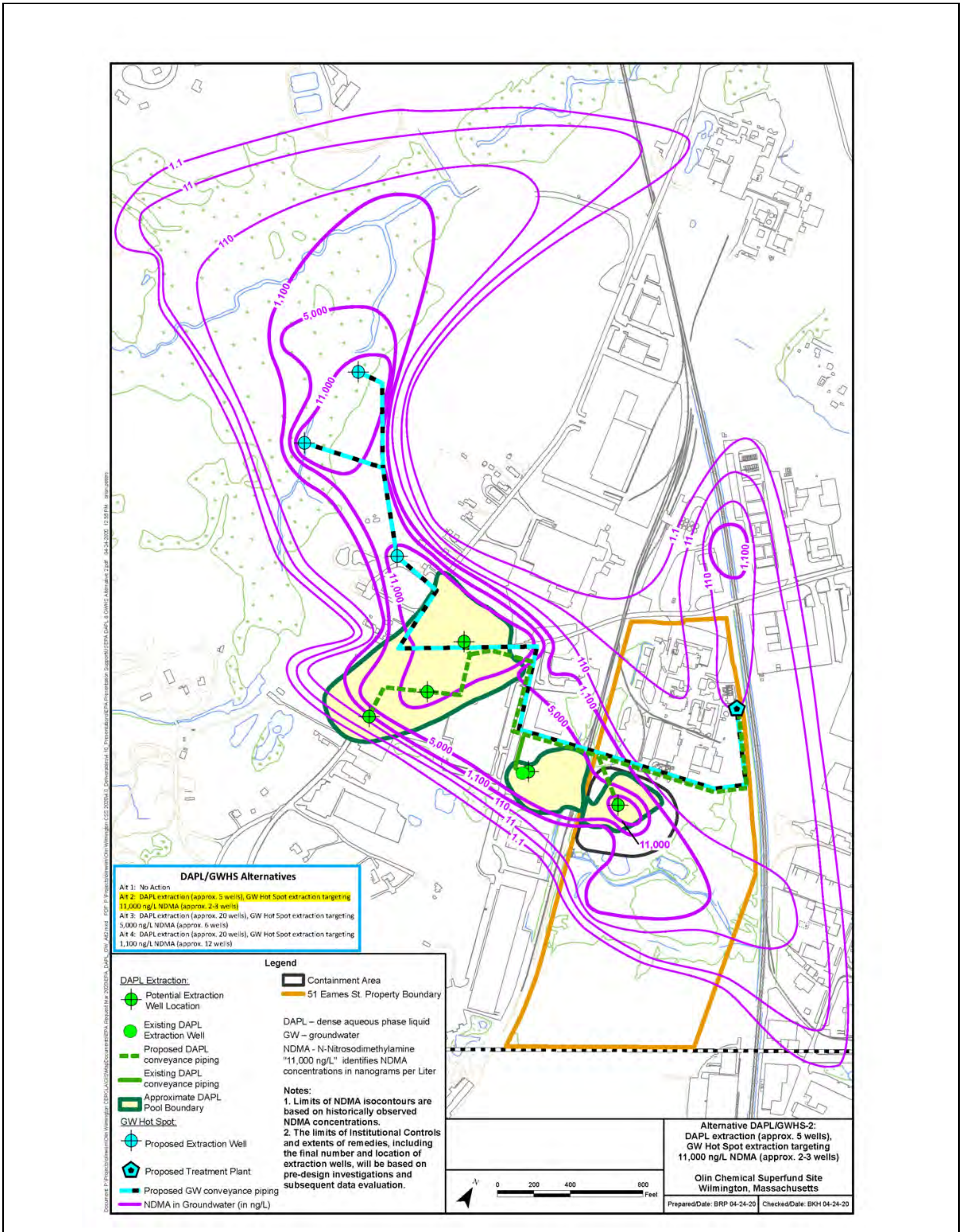

Figure 1. Conceptual plan for Alternative DAPL/GWHS-2. Dense Aqueous Phase Liquid (DAPL) extraction (approximately 5 wells), groundwater hot spot extraction targeting 11,000 nanograms per Liter (ng/L) n-nitrosodimethylamine (NDMA; approximately 2-3 wells), and on-site treatment at a new treatment system.

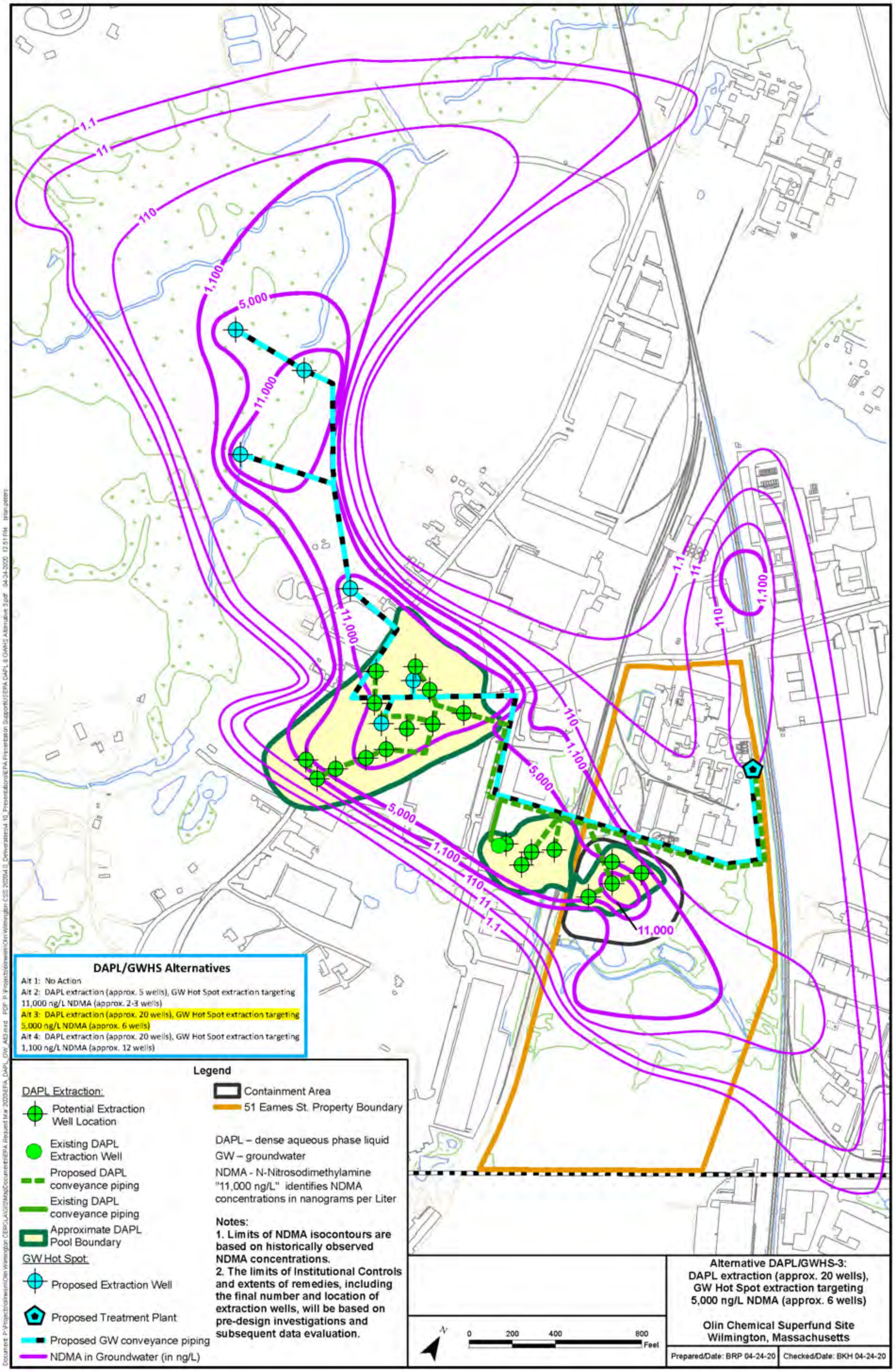

Figure 2. Conceptual plan for Alternative DAPL/GWHS-3. Dense Aqueous Phase Liquid (DAPL) extraction (approximately 20 wells), groundwater hot spot extraction targeting 5,000 ng/L n-nitrosodimethylamine (NDMA; approximately 6 wells), and on-site treatment at a new treatment system.

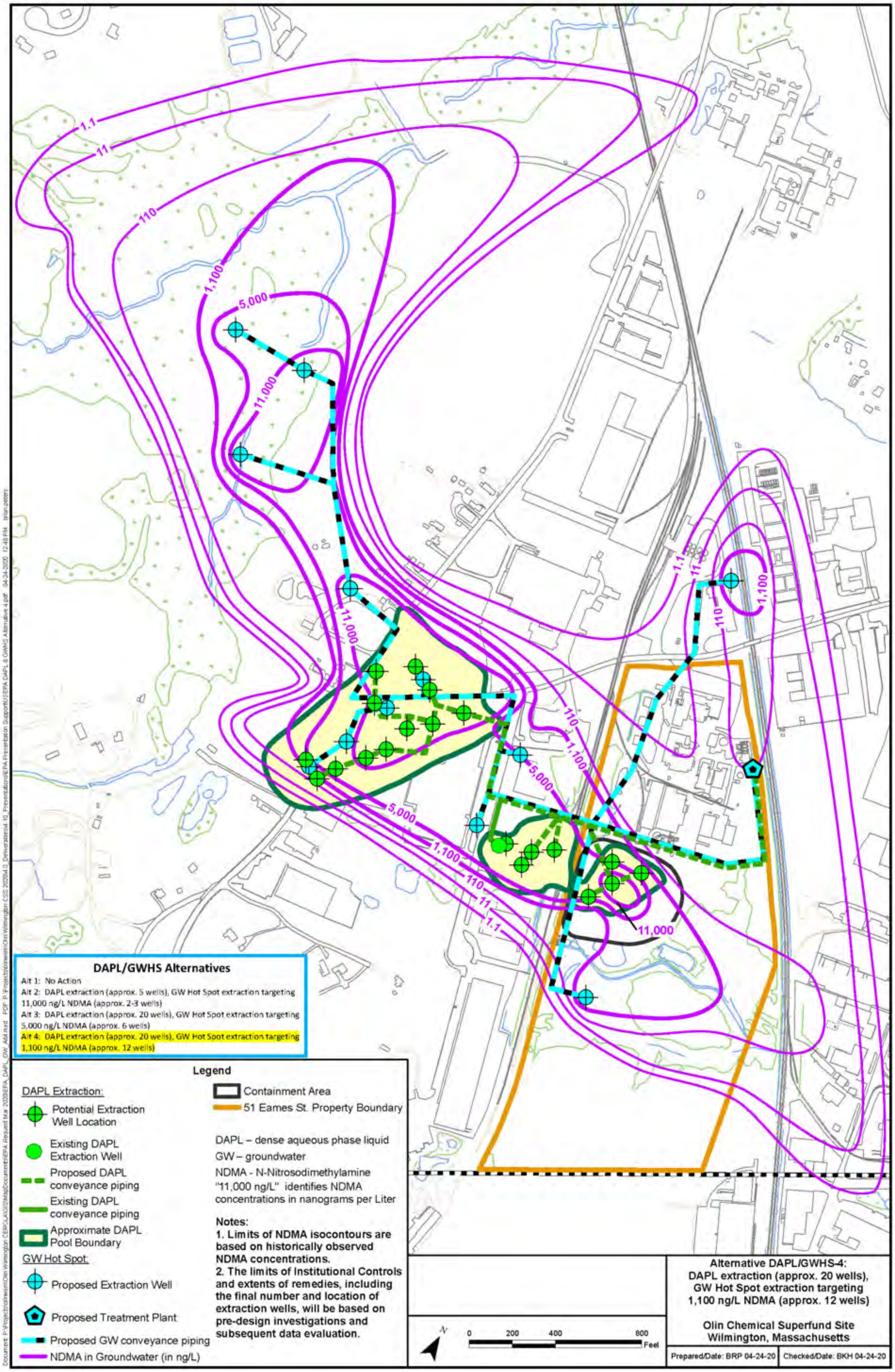

Figure 3. Conceptual plan for Alternative DAPL/GWHS-4. Dense Aqueous Phase Liquid (DAPL) extraction (approximately 20 wells), groundwater hot spot extraction targeting 1,100 ng/L n-nitrosodimethylamine (NDMA; approximately 12 wells), and on-site treatment at a new treatment system.

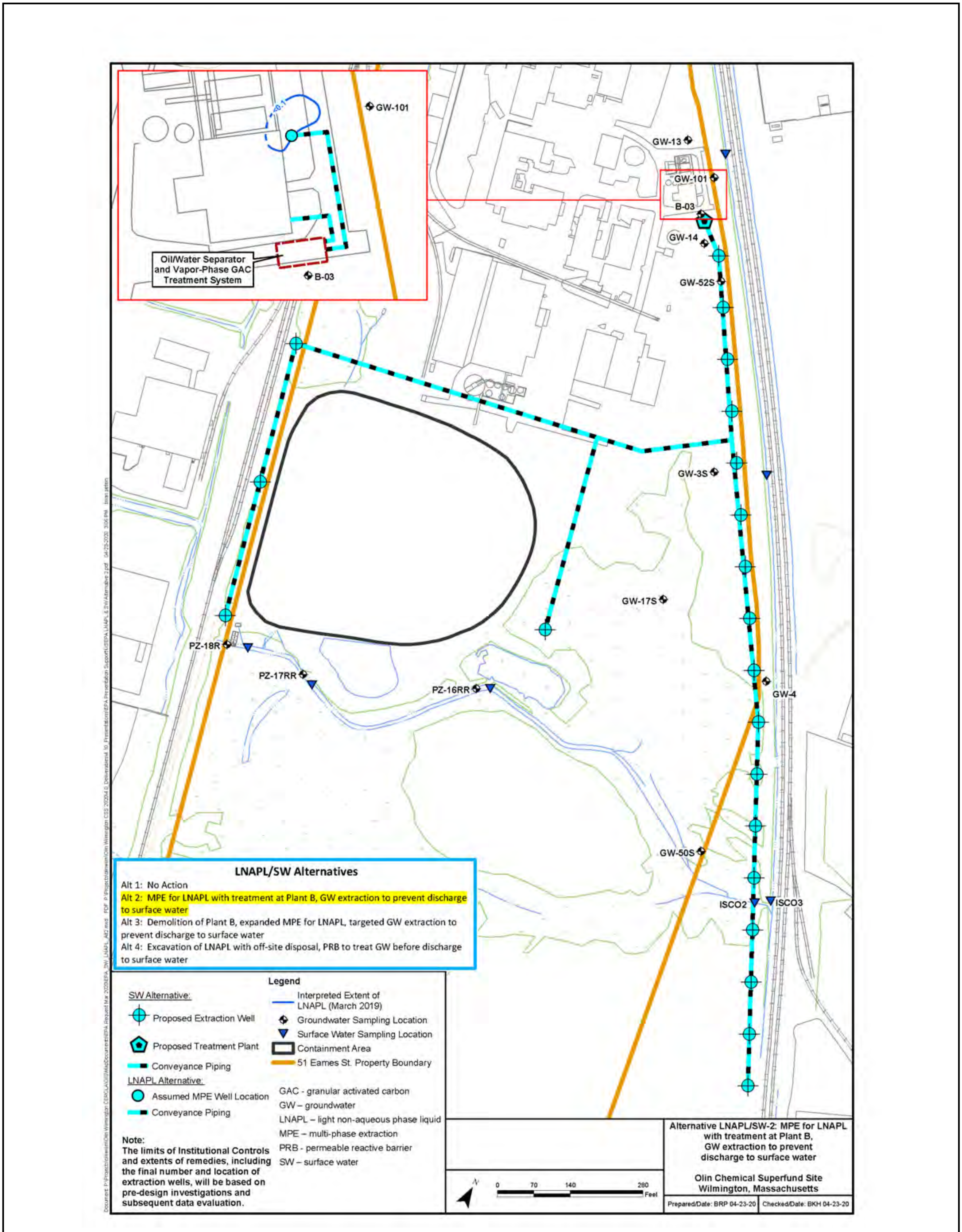

Figure 4. Conceptual plan for Alternative LNAPL/SW-2. Multi-phase extraction (MPE) for Light Non-Aqueous Phase Liquid (LNAPL) with treatment at Plant B, groundwater extraction to prevent discharge to surface water, and on-site treatment at a new treatment system.

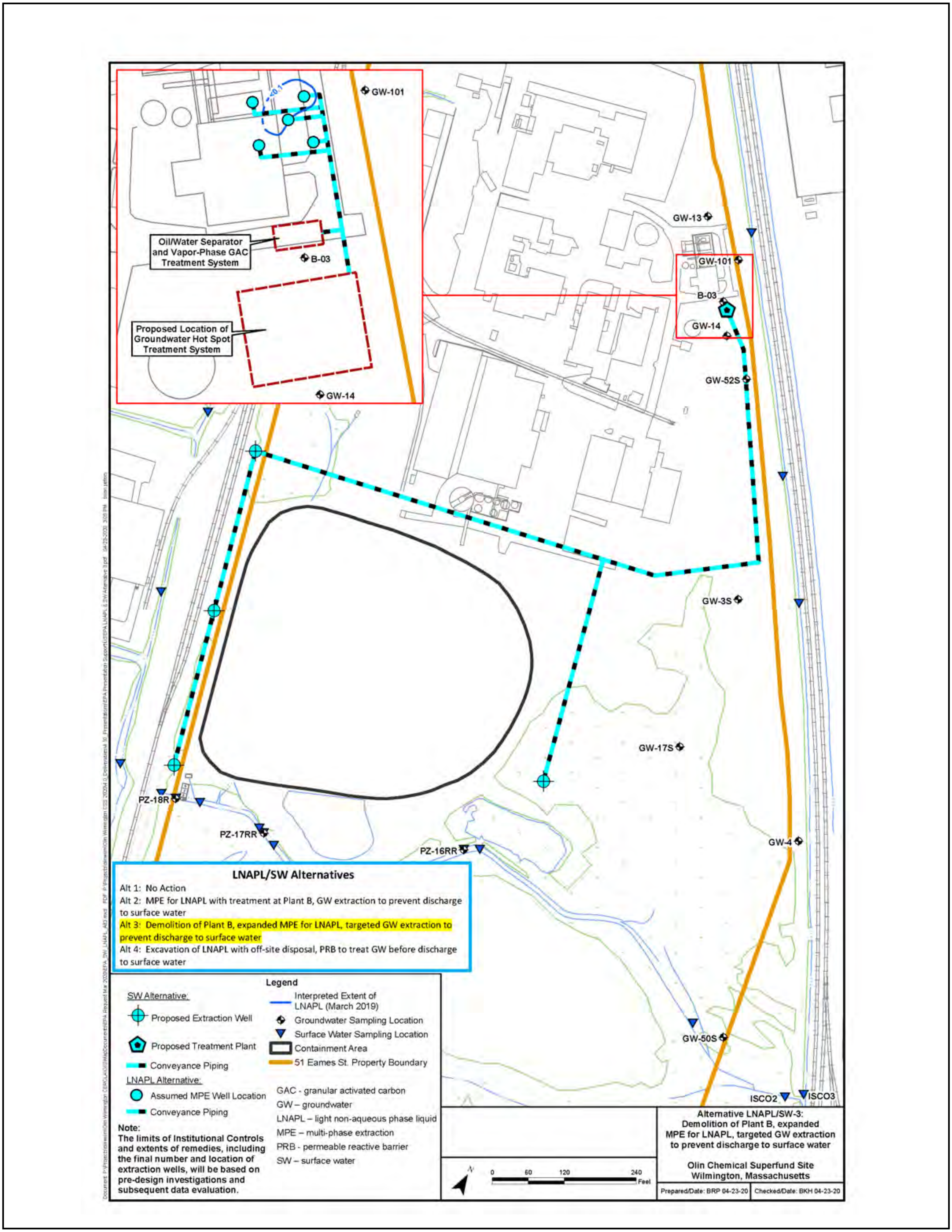

Figure 5. Conceptual plan for Alternative LNAPL/SW-3. Demolition of Plant B, expanded multi-phase extraction (MPE) for Light Non-Aqueous Phase Liquid (LNAPL), targeted groundwater extraction to prevent discharge to surface water, and on-site treatment at a new treatment system.

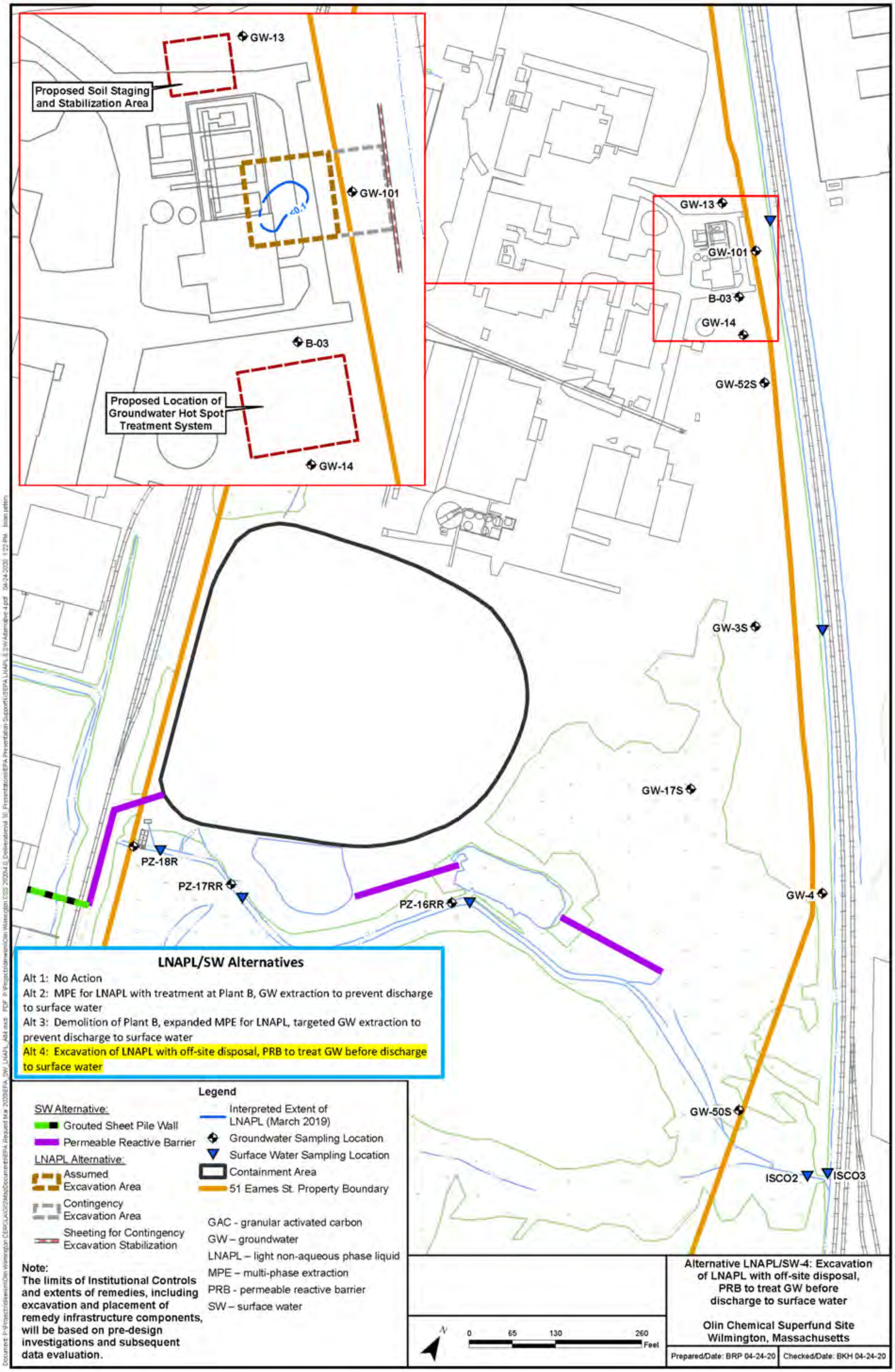

Figure 6. Conceptual plan for Alternative LNAPL/SW-4. Excavation of Light Non-Aqueous Phase Liquid (LNAPL) with off-site disposal, and Targeted Permeable Reactive Barriers (PRBs) to treat groundwater before discharge into surface water.

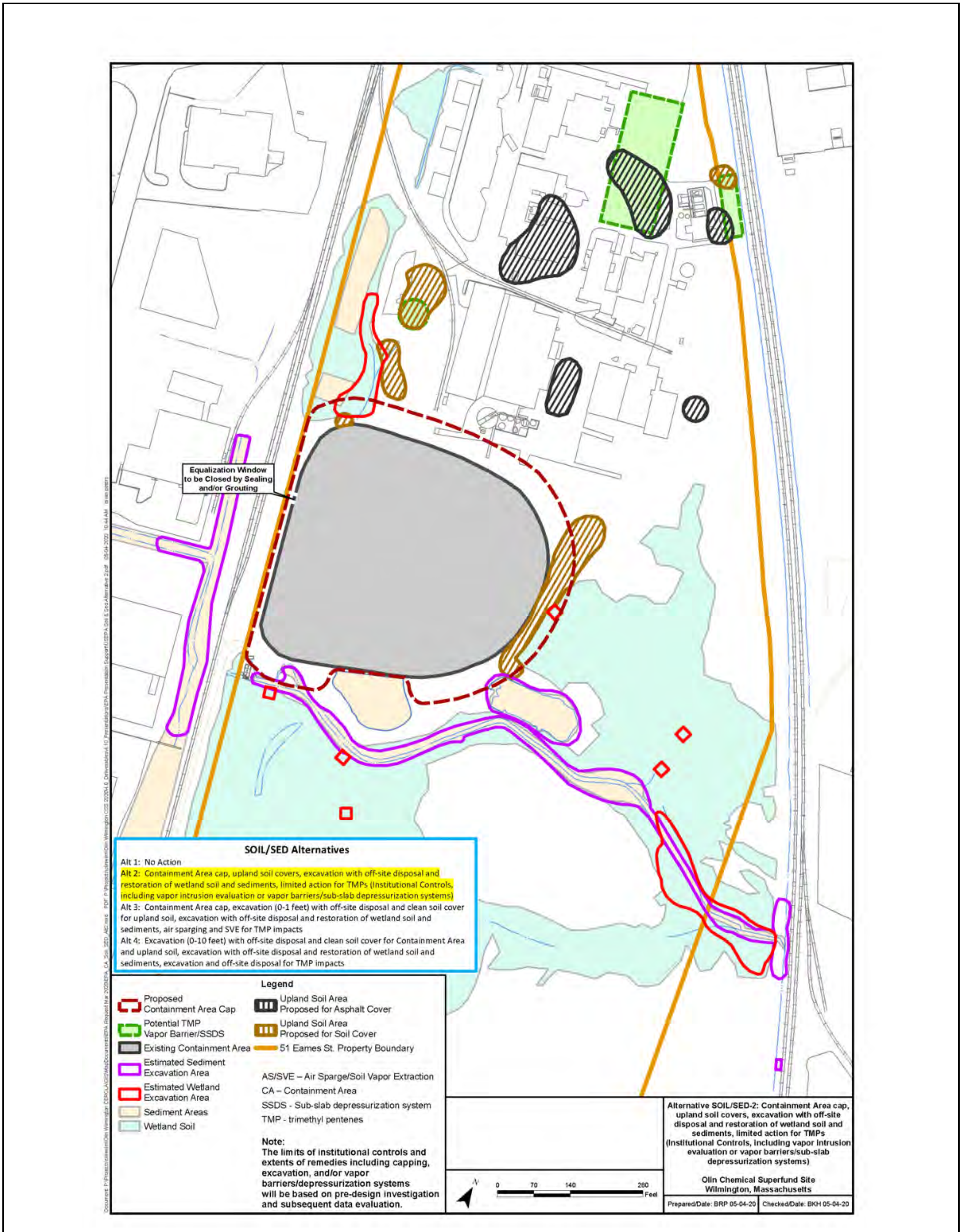

Figure 7. Conceptual plan for Alternative SOIL/SED-2. Containment Area cap, upland soil covers, excavation with off-site disposal and restoration of wetland soil and sediments, and limited action for trimethylpentenes (TMPs) – Institutional Controls, including vapor intrusion evaluations or vapor barriers/sub-slab depressurization systems.

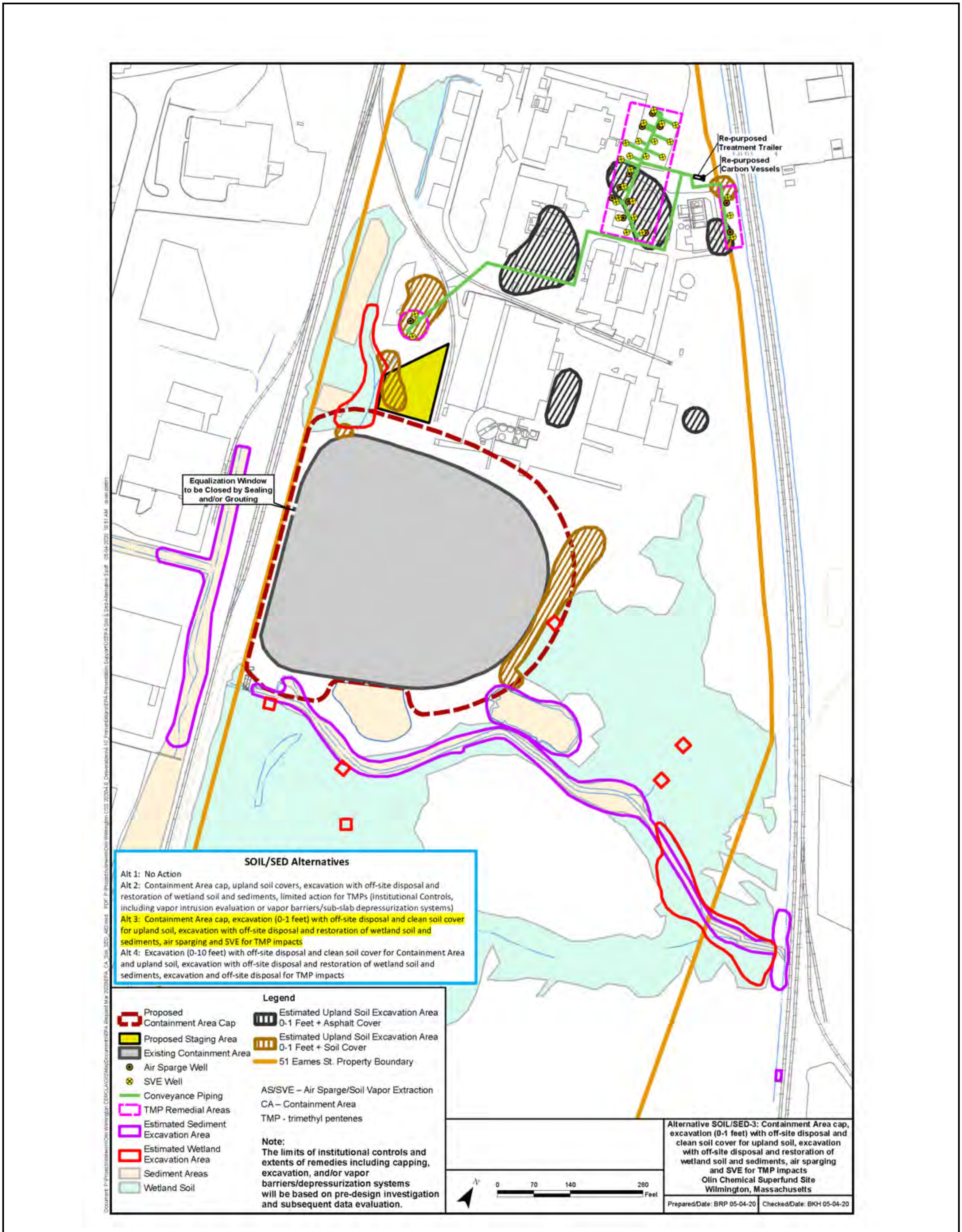

Figure 8. Conceptual plan for Alternative SOIL/SED-3. Containment Area cap, excavation (0-1 feet [ft]) with off-site disposal and clean soil cover for upland soil, excavation with off-site disposal and restoration of wetland soil and sediments, and air sparging and soil vapor extraction (SVE) for trimethylpentenes (TMPs).

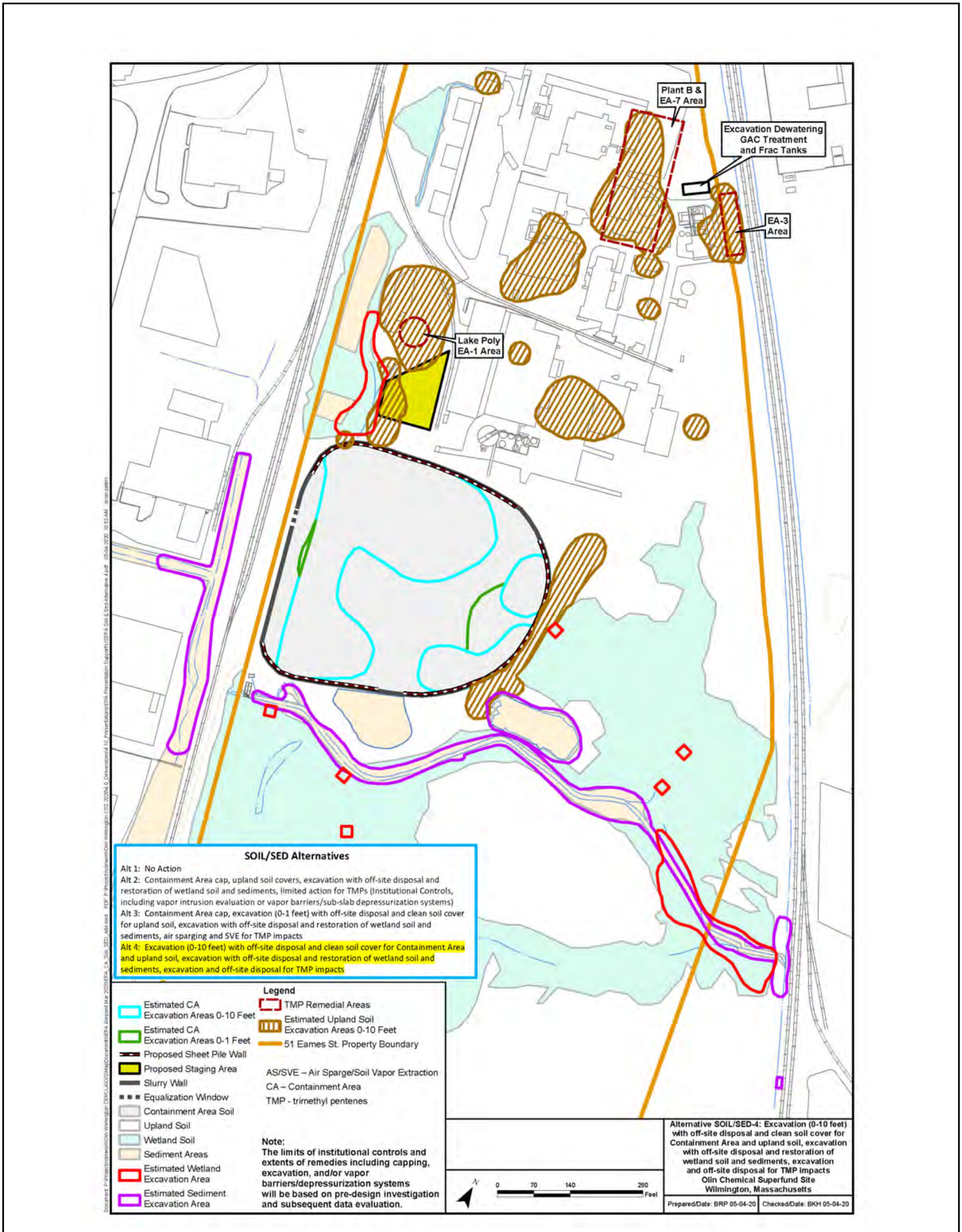

Figure 9. Conceptual plan for Alternative SOIL/SED-4. Excavation (0-10 feet [ft]) with off-site disposal and clean soil cover for Containment Area and upland soil, excavation with off-site disposal and restoration of wetland soil and sediments, and excavation and off-site disposal for trimethylpentenes (TMPs).

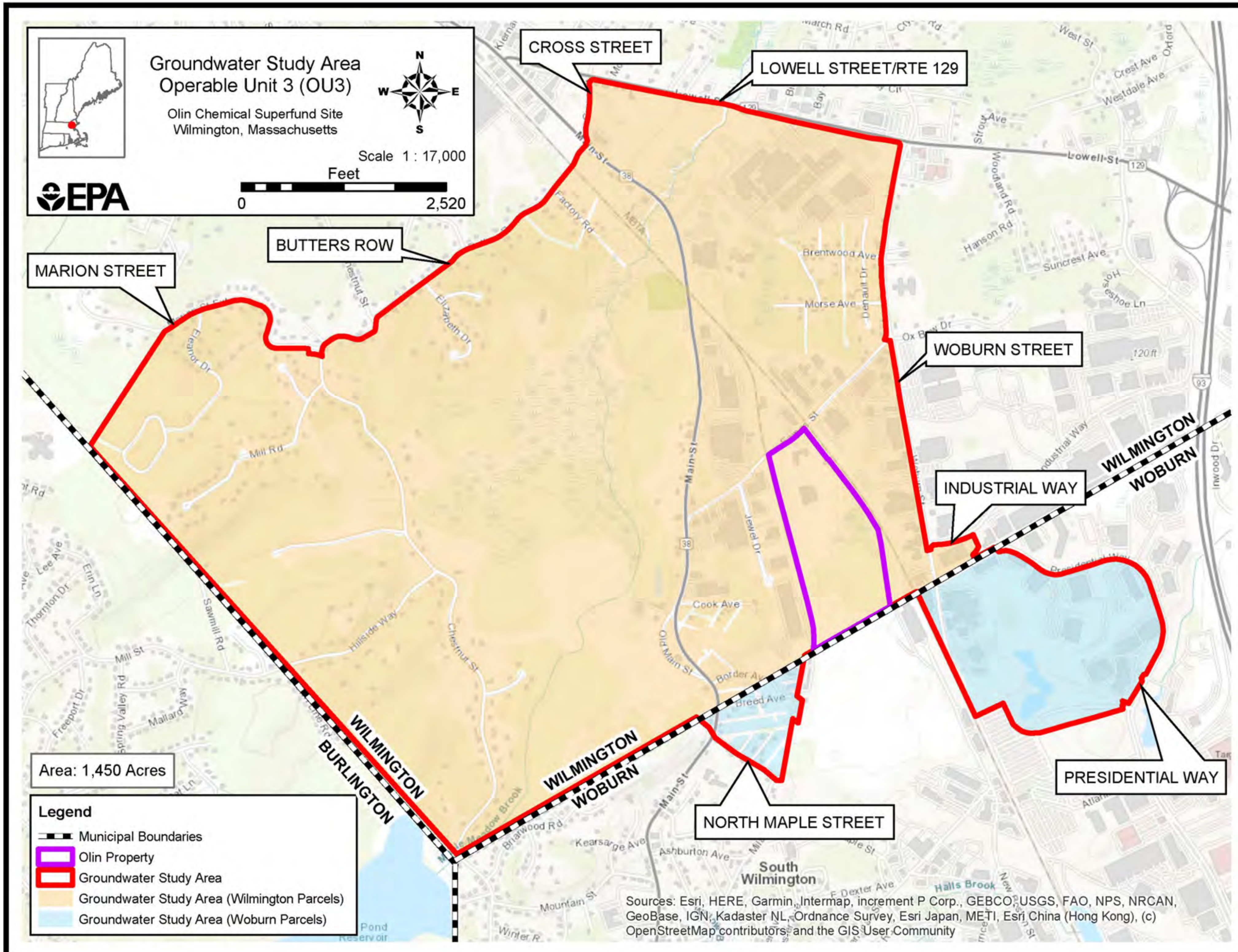

Figure 10. Operable Unit 3 (OU3) Groundwater Study Area and Extent of Groundwater Institutional Controls. Within this area, groundwater use will be restricted until final groundwater cleanup levels are selected and achieved in the final remedy for the Olin Site.